"A STUDY TO FIND OUT THE RELATIONSHIP BETWEEN PHYSICAL PERFORMANCE AND MENOPAUSE AMONGST HEALTHY PRE AND POSTMENOPAUSAL FEMALES-CROSS SECTIONAL OBSERVATIONAL STUDY"

Dr. Kajal Anadkat[1], Dr. Ashika Tanna[2]

1. M.P.T. Musculoskeletal and sports science, Assistant Professor, School of Physiotherapy, R.K.University, Tramba, Gujarat
   Mail ID. Kajal.anadkat@rku.ac.in/kjl.anadkat@gmail.com
   Contact No. +91-9429566176
2. M.P.T. Orthopaedics, YTTC, Assistant Professor, School of Physiotherapy, R.K.University, Tramba, Gujarat
   Mail ID. ashika.tanna@rku.ac.in / dr.ashikatanna89@gmail.com
   Contact No. +91-9978469090

ABSTRACT

Background: Menopause is a transition period characterized by physiological, psychosocial, and sociological changes that accompany the depletion of ovarian function. It is a natural end of women years of having a regular monthly period, which also implies the end of her ability to get pregnant. Poorer subjective physical status has been reported by post menopausal women compared with premenopausal women. Available literatures had analyzed the changes in physical performance due to menopause were of varying etiology of menopause. **Purpose:** The aim of this study to find out whether natural menopause affects the physical performance (grip strength, static balance and hamstring flexibility) i.e. in postmenopausal females. **Methodology:** The study was conducted on 250 healthy premenopausal females with regular periods with a mean age of 42.12±1.768(SD) years and 250 healthy post menopausal females with natural history of menopause with a mean age of 50.188±3.122(SD) years. The grip strength, hamstring flexibility and static balance were measured using jamar hand held dynamometer, modified sit and reach test and OLST respectively.

Results: Intergroup comparison was done by unpaired't' test. The result revealed that there was a significant difference in grip strength ($t=6.578$, $p<0.05$) and static balance ($t=16.895$, $p<0.05$) but not in hamstring flexibility ($t=1.506$, $p>0.05$) among postmenopausal females.

Conclusion: There is a reduction of grip strength and static balance among post menopausal females causing diminished physical performance with age advancement.

KEY WORDS
Menopause, Grip strength, Hamstring flexibility, Static balance, Jammer hand held dynamometer, One leg stance test, Modified sit and reaches test, Physical performance

BACKGROUND

Menopause refers to the natural end of women years of having a regular monthly period, which also implies the end of her ability to get pregnant. It is a transition period characterized by physiological, psychosocial, and sociological changes that accompany the depletion of ovarian function.[1] Although the menopause is a part of the normal aging process, the hormonal changes occurring at this stage of life alter the health risk profile of women.[2] It is a generally considered as a risk factor for increased estrogen deficiency morbidity[3] which evokes musculoskeletal impairments.[4] It has been projected that by age of 45 year, at the time of menopause, up to 10–15% of women could be classified as disabled.[5] Many studies highlighted that the menopause is associated with deteriorating quality of life and major health concern worldwide.[6]

Menopause is the permanent cessation of the primary functions of the human ovaries.[7] The cessation of the ovarian function at the time of menopause resulted into hormonal changes, which are associated with specific health conditions that are unrelated to those typically attributed to aging.[8] It typically (but not always) occurs in women in midlife, during their late 40s or early 50s, and it signals the end of the fertile phase of a woman's life. It has a wide starting range, but can usually be expected in the age range of 42–58 years.[7] The average menopausal age of indian female is 45 years and the western female is 51 years.[1] An early menopause can be related to cigarette smoking, higher body mass index (BMI), racial and ethnic factors, illnesses, chemotherapy, radiation and the surgical removal of the uterus and/or both ovaries.[9]

The process of changing hormone levels during menopause can last for more than 10 years and women may experience widely varying hormone levels, specifically estrogen, progesterone, follicle stimulating hormone, and luteinizing hormone. These hormones alone, and in combination, are responsible for a wide range of processes within the body. The changes that occur during this stage of life may result in disruptions to normal daily living.[10] Premenopause is a word used to describe the years leading up to the last period, when the levels of reproductive hormones becomes lower and more erratic, and the effects of hormone withdrawal may be present.[9] While postmenopause is the period in which women have not experienced a menstrual bleed for a minimum of 12 months, assuming that they do still have a uterus, and are not pregnant or lactating.[7]

Menopause is associated with significant reductions in circulating estrogen levels in females. It plays an important role in the maintenance of many tissues and organs function including skeletal muscles, nerves and neural tissues in females.[11] Estrogen receptors have also been found to exist in skeletal muscle. Deficiency in hormonal level affects the skeletal muscle function and cause decline in activities of daily living (ADL).[12] In particular, a number of studies have suggested that estrogen play an important role in maintaining muscle strength, enhancing muscle repair and

maintaining neurological function in older females. Hence the postmenopausal reduction in circulating estrogen levels may have implications for age related declines in muscle strength and function, mobility, adaptations to training, propensity for falls and balance control. These changes may have profound implications for the long-term health, independence and quality of life for older women.[11]

Measurement of physical function has evolved a critical element in aging as a part of a conceptual framework which is used to consider the transition of healthy adults from full independence through increasing vulnerability to disability and ultimately death. Physical functioning represents an integrated marker of aging, influenced by a broad array of physiological and clinical characteristics interacting with behavior and the social environment.[5]

Muscular strength, flexibility, and balance are the key components of physical performance. Many literatures highlighted that an ability to perform a physical task at a desired level is decreased in postmenopausal women.[1] Poor physical performance predicts frailty, disability and loss of independence among elderly.[1,13] Physical Performance is lower in women compared to men and it is decreased with age in women compared to men and that suggests that gender specific factors across life may influence maximum level of physical performance achieved and performance rate declines with age.[13] Hence, there is a growing interest in studying the effects of the deficit in estrogen in postmenopausal women's physical health and function.[14] Maintaining good physical function with age is a vital component of independence in later stage of life, as poor physical functioning is associated with institutionalization, hospitalization, and mortality.[5]

Muscle strength plays a widely recognized key role in overall functional status of the women.[15] It begins to decline during the postmenopausal years and this phenomenon seems to be partly estrogen dependent.[16] Sudden decline in muscle performance coincides with the menopause[12] because muscle mass and strength exert an important impact on bone strength.[16] Acceleration in the loss of muscle mass and strength have been observed in women during postmenopausal years.[1] Good muscle strength can prevent fragility fractures and lessen the burden of osteoporosis in postmenopausal women.[16]

Muscle performance is an important determinant of functional capacity and quality of life among the elderly and is also involved in the maintenance of balance.[16] Balance can be defined as the ability to maintain equilibrium by positioning our centre of gravity over base of support. (BOS).[17] It is achieved by the complex integration and coordination of multiple body systems including the vestibular, visual, auditory, motor, and higher level premotor systems.[18] Many literature showed weakness in bone and changes of muscle status in postmenopausal women causes modifications in posture and increasing the probability of falls and fracture. Since the center of gravity is modified, it leads to a loss of body balance. Ultimately poor balance results in difficulties in performing daily activities and increases the risk of falls.[19]

Postmenopausal estrogen deficiency causes several physiologic changes in body composition such as increase in fat mass, a decrease in lean body mass, and a decrease in bone mineral density (BMD). Together, these changes increase the risk of fall and fractures in postmenopausal women.[20] Fall incidence is three times higher in postmenopausal women than in men within the same age group. Estrogen withdrawal in

menopause is suggested to affect postural stability via reducing the speed of information processing to the brain.[21] Falls resulting in fractures to postmenopausal women may seriously hinder quality of life and lead to high morbidity and mortality, as well as an increase in direct costs for health services.[22] Even falls without complications may lead to decrease in self confidence and quality of life.[21]

J. P. greeves et al, (1999) suggested that weakening of the quadriceps result in a greater number of falls in postmenopausal females. This would present important clinical implications for these women, who are already prone to losing bone density at rapid rate following the menopause. He also explained that muscle strength of the quadriceps declines at a rapid rate within the first 3 years of postmenopause due to the hormone deficiency during menopause. This strength loss, which mirrors the accelerated loss of bone mineral density, presents a complex interaction between muscle weakness, bone loss and the associated risk of fracture. He suggested that decline in muscle strength reported after the menopause can be explained by a decline in physical activity levels at this time.[23] **Stephen D. Perry et al., (2005)** suggested that estrogen may enhance and maintain muscle strength in females and its loss may be related to strength declines associated with aging in older females. Thus the menopause related to loss of estrogen could predispose females to further strength losses.[11]

Flexibility is also the key component of physical performance. The loss of muscle mass and the accumulation of fat during menopause could cause discomfort and stiffness in muscles and joints. During menopause, there is a losing of cartilage as well as decreased fluid between the joints leads to stiffness in the joints and muscles. Decrease in estrogen can be an attributing factor to muscle stiffness experienced by menopausal and postmenopausal women. Although aging causes loss of muscle mass, changes in the release of hormones are believed to accelerate loss of muscle mass and decreases in muscular function.[24]

Many literatures showed that practicing regular physical exercises minimizes changes resulting from menopause as reflected by improved body composition, decreased joint pain and vascular resistance, increased bone mineral density, aerobic capacity, muscle strength and flexibility.[25] The positive outcomes resulting from regular exercise and/or physical activity programs include increased cardiovascular fitness, decreased anxiety and depression, and enhanced feelings of well being. Additionally, exercise and/or physical activity has, in some cases, been shown to decrease feelings of fatigue and chronic muscle pain, improve quality of life.[10]

The association between menopause and physical performance has been examined in a limited number of studies. There are some evidences that postmenopausal woman has lower levels of muscle strength and physical function than premenopausal women, although this has not been consistently shown. It is also unclear whether the associations found are independent of changes in performance associated with general ageing.[13]

The difference in the physical performance can be analyzed clinically by hand grip strength, flexibility and balance.[1] Handgrip strength is an excellent outcome predictor of functionality, nutritional status, and mortality in elderly people.[26] It is positively related to lower and upper muscular strength so that it is considered a

surrogate measure of overall muscular strength.[15] There is a role of hormonal component in the regulation of force production which has been indicated for hand muscles.[23] Hand grip strength is a valid and most feasible bed side method, which makes it attractive and the most frequently used tool for clinical purpose.[27] The Jammer hand held dynamometer was found to be highly reliable (ICC=0.98, p<0.05) and valid (ICC=0.99, p<0.05) tool to measure hand grip strength,[28] which is simple, easy and noninvasive tool that measures grip strength.[26]

The modified sit and reach test which is proposed by **Hopkins and Hoeger (1986)** is a valid and reliable (ICC=0.66, p<0.05) method to measure hamstring flexibility. This is a modified version of the traditional sit and reach test, designed to control for the variable lengths of people's arms and legs, which is a limitation of the standard test. In this test, the zero mark is adjusted for each individual, based on their sitting reach level.[29]

One Leg Stance Test (OLST) is a simple test to measure static balance which requires minimal equipment and training.[30] It is inexpensive and less time consuming method that correlates with other balance tests.[31] It is a valid measure that is useful in explaining variables such as frailty, self-sufficiency in activities of daily living (ADL), gait performance, and fall status.[30] It is a quick and effective method to screen for balance impairment that measures postural stability (i.e., balance) which is more difficult to perform due to the narrow base of support required. It is a reliable (between raters ICC=0.95-0.99, within raters ICC=0.73-0.93) and easy method for clinicians to screen the patients for fall risks.[32]

Many women experience limitations in physical function during postmenopausal periods. Whether these limitations represent a decline in physical function due to aging, changes in hormonal status associated with menopause, or other factors are still controversial.[33] Increased female vulnerability related to aging, together with predominance of female elderly population, makes them an important target for research and preventive health care measures.[4] Physical performance can be assessed clinically by measuring the strength, flexibility and balance between premenopausal and immediate postmenopausal females population with history of natural menopause.[1] So the purpose of the study is to find out the relationship between physical performance and menopause amongst healthy premenopausal with regular periods and postmenopausal females with natural history of menopause.

METHOD

250 healthy postmenopausal females with age group of 45-55 years [**50.188±2.835(SD)]** were selected for the study who fulfilled the inclusion and exclusion criteria. The proposed title and procedure was being approved by ethical committee member. The details and purpose of the study were explained to all subjects and written consent was taken from them. All subjects met the following inclusion criteria: (1) Premenopausal females (40-45 years) with the regular periods.(2) Postmenopausal females (45-55 years) with natural history of menopause.(3) Menopausal rating scale (MRS) to confirm menopause.Subjects were excluded with following exclusion criteria: (1) History of any neurological, vestibular and musculoskeletal disorders.(2) Pregnant women. (3) Females with hearing impairment.(4) Subjects with abnormal vision.(5) Subjects with history of recurrent falls in past 1 year(6) Subjects with surgical

menopause (hysterectomy).(7) Subjects who were on hormonal replacement therapy (HRT).(8) Simplified Calculated Osteoporosis Risk Estimation (SCORE) greater than 6.

Study Design

- The selection of subjects was done by purposive sampling. A total number of 250 subjects of premenopausal females with regular periods and 250 subjects of post menopausal females with natural history of menopause were selected from different areas of rajkot city for the study.
- Study was explained to the patients with their consent and by taking history females were purposively included in two groups:

Group A: Premenopausal females (n=250, age: 40-45 years)

Group B: Postmenopausal females (n=250, age: 45-55 years)

Assessment

- Grip strength, hamstring flexibility and static balance were measured in both the groups with mean of the three trails were taken into consideration.

Testing procedure:

1. Strength Assessment:[1](Fig A)

- A subject was asked to sit on a chair with arms at right angle and elbow by the side of the body with forearm supported on chair.
- Hand held dynamometer was held in the dominant hand and directions given to squeeze the dynamometer with the maximum isometric effort.

Flexibility Assessment:[28](Fig B)

- A subject was asked to take a long sitting position with back and head against a wall with the legs straight ahead and knees flat on the floor (i.e. long sitting).
- Then, a flexometer was placed against the subjects' feet while keeping the back straight and ask the subject to stretch their arms out towards the box.
- Subjects was instructed not to jerk or bounce to reach further and hold the full reach position for two seconds, and score (i.e. reach distance) was recorded

Balance Assessment:[60](Fig C)

- A subject was asked to stand barefoot on a flat and hard surface.
- The therapist was standing close to subject to prevent fall.
- Then subject was asked to close the eyes and lift one foot from the ground

- The time was recorded by stopwatch and if the subject raises foot begins to lower or touch the ground, begin to sway, or open the eyes then stop the watch and note the time.

STATISTICAL ANALYSIS

All Statistical analysis was done by software SPSS 14.0 version. Mean and Standard Deviation (SD) were calculated as a measure of central tendency and measure of dispersion respectively. Comparison of grip strength,static balance and flexibility between the Group A and Group B was done by unpaired‘t’ test.

RESULT

The finding of present study clinically supports our alternative hypothesis for grip strength and static balance and null hypothesis for flexibility. Our result reveal significant difference in grip strength and static balance in postmenopausal females.

Inter group comparison of grip strength in Group A and Group B

	Mean (Kg)	SD	t	p	Result
Group A	23.7827	4.07103	6.578	<0.05	S
Group B	21.5133	3.63041			

Inter group comparison of modified sit and reach test in Group A and Group B

	Mean (Cm)	SD	t	p	Result
Group A	6.7310	6.35882	1.506	>0.05	NS
Group B	5.8705	6.41891			

Inter group comparison of OLST test in Group A and Group B

	Mean (Sec)	SD	t	p	Result
Group A	7.6421	3.94470	16.895	<0.05	S

Group B	2.7645	2.29725			

Graphs representing inter group comparision of grip strength,Flexibility and static balance respectively.

DISCUSSION

Menopause can be officially declared when there has been amenorrhea (absence of any menstruation) for one complete year. The transition from reproductive to non-reproductive is the result of a reduction in female hormonal production by the ovaries. Signs and symptoms of menopause includes irregular menses vasomotor instability (hot flashes and night sweats), atrophy of genitourinary tissue, increased stress, breast tenderness, vaginal dryness, forgetfulness, mood changes, and in certain cases osteoporosis and/or heart disease. These effects are due to the hormonal changes which affect each woman to a different extent.[9]

Physical performance is an ability of an individual to perform any physical task at a desired level.[1] There is a greater decline in physical performance in women than in men of same age so the possible reason for that is changes in estrogen levels in aging women.[33] The component of outcome measure were taken are hand grip strength, hamstring flexibility and static balance. The result of our present study support the experimental hypothesis for hand grip strength ($t=6.578, p<0.05$),static balance ($t=16.895, p<0.05$) and null hypothesis for hamstring flexibility ($t=1.506, p>0.05$). The findings of this study suggest that balance ability and hand grip strength but not the flexibility is affected among immediate postmenopausal females; as flexibility were almost similar between the two groups.

Study done by **Tseng et al., (2012)** support the result of the present study and he explained that postmenopause status is associated with self-reported limitations in physical function and reported that physical function were limited higher in postmenopausal women, whether naturally or surgically than in premenopausal women.[35]

Bimali et al., (2012) examined the changes in physical performance (grip strength, static balance and flexibility) in immediate postmenopausal women and suggested that lower limb muscles flexibility and upper limb strength did not show any significant changes among immediate postmenopausal females; but static balance was significantly affected among the post menopausal females causing diminished physical performance with age advancement[1] that support the result of the present study that the static balance significantly decline in postmenopausal females.[1]

Hand grip strength is significantly reduced in postmenopausal females. Handgrip strength has been demonstrated as an approximation of total body muscle

strength and a powerful predictor of late-aged functional capacity.[11] Estrogen has an anabolic effect on muscle by the stimulation of Insulin like growth factor-1 (IGF-1) receptors. In addition, there is some evidence that estrogen receptors (ER) are present in human muscles in the form of ERα and ERβ in the nuclei of muscle fibers and capillaries. Interestingly, it has been shown that the number of ERs on muscle fibers is greater in men, women and children, as compared to postmenopausal women. Noteworthy, estrogen receptors are not only dependent on circulating estrogen to be activated but IGF-1 can also activate the transcriptional activity of estrogen receptors. Hence, estrogen receptors could play their role on muscle strength through the action by both estrogen and IGF-1. Nonetheless, both estrogen and IGF-1 drop at menopause, which is likely to affect muscle mass and strength explained by **Maltais M.L (2009)**[14]

Present study showed significant changes in hand grip strength which was supported by the study of **Lianne M. Kurina et al., (2004)**, he suggested that progression to postmenopausal status was associated with a significant decline in pinch strength and a marginally decline in grip strength for all women. Grip strength and pinch strength was significantly weaker in post menopausal women than in premenopausal women as estrogen could influence the number or force production of cross bridges in the muscle.[33]

Bassey et al., (1996) found divergent results on the effects of estrogen on muscle strength which showed no difference in hand grip strength between women of different hormonal status and found that there is no protective effect of estrogen on muscle strength. It is possible that estrogen does not have the same physiological effect in younger than in older women and it is thus hazardous to generalize to the postmenopausal population.[14]

Flexibility was not significantly reduced among postmenopausal females. This could be because of narrow age differences among the subjects. Since reduction in flexibility secondary to aging occurs rapidly after 65 years of age (i.e. especially of lower limb muscles).[1]

No significant changes was seen in flexibility among postmenopausal females that is supported by the study was done by **Cheng et al**., **(2012)** who examined that the menopause is associated with decreased physical performance and determine the risk factors accounting for a decline in physical performance and suggested that flexibility did not vary among different menopausal status females.[43]

The result of present study showed significant reduction in static balance among the postmenopausal females. Proprioception from the leg muscle is essential for maintaining balance while standing on one leg with eyes closed.[11] The most optimal reason for reduction in static balance can be attributed to the three strategies adopted by an individual to maintain the upright posture and to recover the balance: hip, ankle, and stepping strategy. One relies on ankle strategy when displacements are in small ranges within the limit of stability. But when oscillations are more and frequency is high, or when the supporting weight bearing surface is small than the foot area; then one shifts to encompass the hip strategy in order to maintain the balance. Also, if the body perturbation is greater, than more people tend to decrease the ankle response leading to increase in hip strategies.[1]

In such situation postural sways increases automatically. This condition probably would have been the reason among postmenopausal females showed decline in static balance as muscles closest to the base of support are particularly important to maintain the balance, so according to that another reason can be given for reduction in static balance is reduced due to reduced ankle dorsiflexor strength among post menopausal females which results in the appearance of early sway among postmenopausal females. Other reason could be the age related decline in muscle strength of lower limb.[1]

Sara Ekblad et al., (2000) mentioned that the sharp increase in the incidence of falls around the time of menopause has been attributed to the menopause related reductions in serum estradiol level (component of estrogen hormone).This study found improvement in postural sway after hormonal therapy among postmenopausal females indicating that reduction of estrogen hormone would cause increase in postural sway among such subjects.[1]

Rachel cooper et al., (2008) showed association between menopausal status and physical performance in midlife which acts through the musculoskeletal system, specifically muscle strength, rather than other systems, such as the CNS or cardiovascular and respiratory systems that can be suggested that there is no change in static balance among postmenopausal females.[13]

Thus the findings of our study indicated that static balance and grip strength but not flexibility deteriorate during the transition through natural menopause. Since compromised physical performance can have substantial impact on the quality of life, which is inevitable with increased life expectancy and therefore, one need to be free of illness in order to function efficiently and effectively in old age. So, as healthcare professional need to develop appropriate preventive measures to improve the static balance and grip strength among immediate post menopausal females.

Study Limitation

- Sample size was small.
- Non consideration of the trunk and lower limb muscle strength and flexibility of the muscles anterior to the hip joints, since these muscles plays major role in maintaining the posture and balance.
- Postmenopausal females age range was larger compare to pre menopausal females.
- Dynamic balance was not assessed in post menopausal females.
- To exclude osteoporosis, Simplified calculated osteoporosis risk estimation (SCORE) was used rather than DEXA which is more reliable but costly.

Recommendations

- Study can be done with larger sample size.
- Future research can be conducted to involve trunk and lower limb muscle strength and flexibility as they play important role for posture in general and balance in particular.

- Posturography can also be used to assess the dynamic balance with focus on various functional life style situations.
- To be specific about osteoporosis/osteopenia, DEXA can be done prior to the study.
- Study can be done with other component of physical performance.(e.g. functional mobility)
- Study can be done in females with surgical menopause (hysterectomy) and females who are on HRT.

CONCLUSION

On the basis of result of the present study, it can be concluded that component of physical performance i.e. grip strength and static balance was reduced but not the flexibility among immediate postmenopausal females due to hormonal changes compared to pre menopausal females.

ABBREVIATIONS

1. **ER-**Estrogen Receptor
2. **IGF-1:**Insuline Like Growth Factor-1
3. **OLST-** One Leg Stance Test
4. **JHHD**- Jamer Hand Held Dynamometer
5. **MRS-**Menopausal Rating Scale
6. **SCORE-**Simplified Calculated Osteoporosis Risk Estimation
7. **QOL-**Quality Of Life
8. **ADL-**Activity Of Daily Living
9. **FMP-**Final Menstruation Period
10. **BMD-** Bone Mineral Density
11. **BMI-** Body Mass Index
12. **HRT**- Hormone Replacement Therapy
13. **TCC-**Tai Chi Chun
14. **COG-**Center Of Gravity
15. **BOS-** Base Of Support
16. **CNS-**Central Nervous System
17. **Kgs-**Kilograms
18. **Cms-**Centimeters
19. **Sec-**Seconds

COMPETING INTEREST

No Competing Interest

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PHOTOGRAPHS:

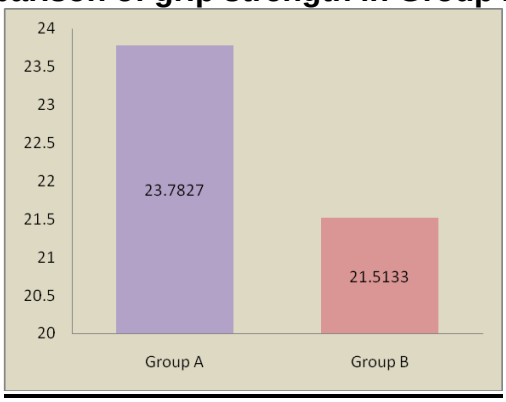
A.Grip strength measurement

B. Flexibility measurement

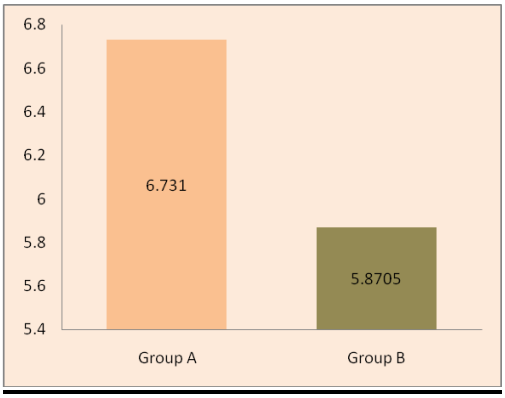
C.Balance measurement

GRAPHS OF STATISTICAL ANALYSIS

1. **Inter group comparison of grip strength in Group A and Group B**



2. **Inter group comparison of modified sit and reach test in Group A and Group B**



3. Inter group comparison of OLST in Group A and Group B