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# Effect Of Different Lumbar Lordotic Angles On Dynamic Postural Stability In Young Adults

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# Effect Of Different Lumbar Lordotic Angles On Dynamic Postural Stability In Young Adults

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## Abstract

**Objectives**: Lumbar lordosis is a main element of the sagittal balance. Improper postural alignment and trunk stability and excessive spine curvatures such as lordosis, kyphosis and scoliosis can impact our balance system adversely. This study was conducted to investigate the effect of different lumbar lordotic angles on dynamic postural stability and limits of stability in young adults.

**Methods**: 100 normal male subjects, their ages ranged from 20 to 35 years, assigned to two equal groups according to lumbar lordotic angle (LLA) Group (A) (n= 50 males) control group with normal angle between 20:60 degrees. Group (B) (n= 50 males) hyper lordotic group with increased angle above 60 degrees; and their BMI ranges between 18.5:24.9 kg/m$^2$. X-ray was done to measure the lumbar lordotic angles using cobb's angle method and the biodex balance system was used for assessment of dynamic postural stability and limits of stability.

**Results**: The study findings using the MANOVA test revealed that there was a significant effect of lumbar lordotic angles on dynamic postural stability and limits of stability ($p = 0.0001$).

**Conclusion**: It was concluded that the difference in lumbar lordotic angles had an effect on dynamic postural stability and limits of stability in young adults. Therefore, subjects with hyperlordotic angles in the lumbar spine reported poor dynamic postural stability and decreased limits of stability than normal ones assessed by biodex balance system.

**Keywords: Lumbar lordotic angles, Dynamic postural stability, Biodex Balance System.**

## INTRODUCTION

Postural balance is the capability to maintain the line of gravity of a body within the base of support. The human body attempts to keep its optimal posture against gravity under static and dynamic circumstances [1]. Good postural stability and mobility are crucial for most daily activities to be performed properly [2]. In order to achieve stability and orientation, postural control includes controlling the position of the body in space. It is a complicated method that requires a centralized processing of peripheral sensory inputs [3]. Recently, experiments had shown that many factors cause postural instability, one of these risk factors for postural instability and falling problems could be postural deformity [4]. Lumbar lordosis is a ventral spine curvature created by lumbar vertebrae wedging and intervertebral discs. Lumbar lordosis is a main element of the sagittal balance maintenance [5].Clinical implications was marked by the optimal alignment of the spine and its position with respect to the pelvis and lower extremities. Also, milder types of deformation can cause the trunk to tilt anteriorly, making the standing balance inefficient [6]. In several research, the link between posture and body balance and/or falling among older adults was examined [7]. Lumbar kyphosis affects the inclination of the spine and standing balance and can be a risk factor for falling. Lumbar kyphosis is an essential factor associated with postural instability and probability of falling in patients with postural deformity [4]. Miyakoshi et al. [8], assessed the effect of postural deformities and mobility of spine on quality of life in these patients and discovered that it was impaired by postural deformities. Spinal mobility has a major effect on the quality of life of postural deformities patients. Various techniques are utilized to assess lumbar lordosis. They indicate that measurements should include L1–L5 vertebral bodies and intervertebral discs; in other words, (Cobb's method) should be carried out between the first lumbar vertebra's upper endplate and the sacrum's upper endplate [9]. Lumbar lordotic angle (LLA); is the angle formed between the cranial endplate of L1 and cranial end of sacral border and it is normal value between 20 º- 60º [9-13].

Postural stability was evaluated using a Biodex Balance System SD (BBS), a measuring and training tool of postural stability on static or unstable surfaces. This device contains a circular platform that can move freely in the anterior-posterior and medial-lateral axes simultaneously, capable of controlling the platform's degree of motion with 12 levels. The device is interconnected with specially developed software to enable it to calculate the degree of tilt in each axis, providing an average sway score [14].

Therefore, this study was designed to determine whether abnormal lumbar lordosis is associated with postural stability and limits of stability in young adults and whether postural stability is influenced by the lumbar lordotic angles change which will help us to prevent postural deformity and to aid in lumbar problems assessment and balance problems.

## MATERIALS AND METHODS

***Study design***

This study was a screening study.

***Participants***

This study was conducted in the Faculty of Physical Therapy outpatient clinic Beni-Suef University in March 2019 to July 2019; to investigate the effect of different lumbar lordotic angles on dynamic postural stability and limits of stability in young adults. The sample size was determined by a power analysis of 100 normal male subjects, assigned to two equal groups according to the lumbar lordotic angle without other deformities at any region in the spine. In standing position x-rays radiographs, the angle between the top of L1 and the top of the sacrum ranges from 20 ° to 60 ° but the mean value is around 50° [15,16]. Group (A) (n= 50 males) control group with normal lumbar lordotic angle between 20:60 degrees and Group (B) (n= 50 males) hyper lordotic group with increased lumbar lordotic angle above 60 degrees. As shown in figure (1).

***Inclusion Criteria:***

The study included one hundred male subjects, their ages ranged from 20 to 35 years and their body mass index (BMI) ranged between 18.5:24.9 kg /m$^2$.

***Exclusion Criteria:***

Our study excluded any subjects with neurological dysfunction or any other pathology that could affect their balance, also with history of previous back surgery or current lower extremity symptoms, nor Symptoms of vertigo or dizziness and no other disorders in the vertebral column (disc prolapse, spondylosis, and fracture) [17]. Also, Smokers had been excluded from the study [18].

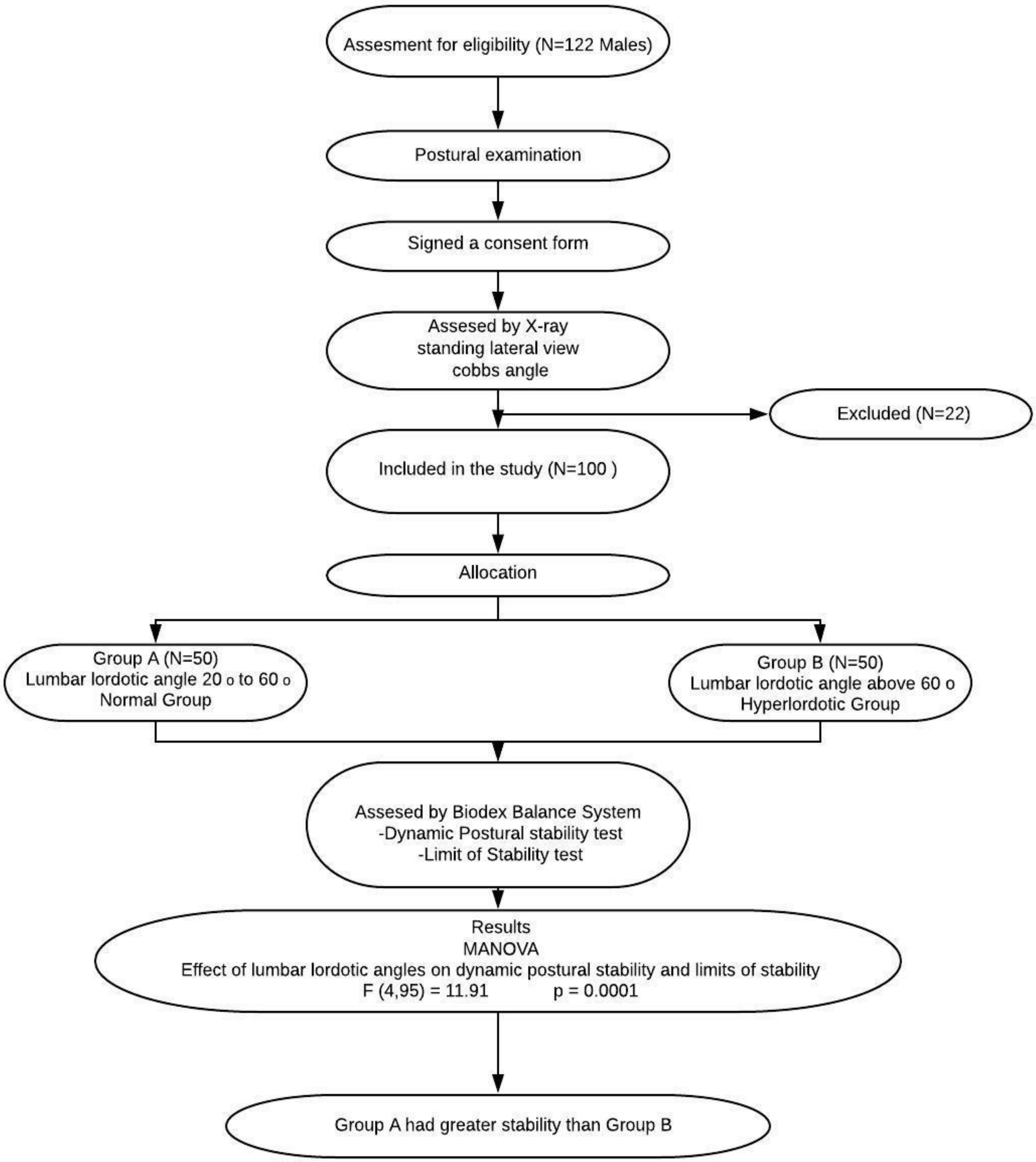


**Figure1**:Flow chart demonstrates the design of the study and results.

*Methods*

• The researcher measured weight and height on the weight and height scale then calculate BMI. The age of subjects was recorded. Subjects were given verbal instructions concerning the purpose and procedure of the study and all the participants signed the consent form.

•All measurements of x-rays lateral views were taken by the same machine and the same examiner participants were in weight-bearing position "loading position".

•Analysis of X-ray film was done in Tiba center in Beni-Suef, Egypt.

***•Lumbar radiography:***

The participants were positioned carefully against the cassette with their side. They were asked to stand erect with their knees extended. The arm was pulled upwards, with their hands behind the neck [19].

***Stability Evaluation procedure:***

- All subjects were tested for dynamic postural stability by the Biodex balance system. (Biodex, Shirley, NewYork, USA).

- Participants were advised to stand in a comfortable place on the platform so that they could stand at both feet until the trial was over. All participants were started a trail, following the test guidelines, which did not collect information. The purpose of this trial was to evaluate the understanding and follow-up by the respondents [20].

***Dynamic postural stability test:***

This test aimed to measure the ability of the participant to maintain his balance on the center of the dynamic platform of biodex during standing on level 8 as a moderate stability and level 1 as the least stability according to Parraca et al. [14]. The test has consisted of 3 trails with the participant opened his eyes for 20 seconds during trial and 10-second rest between trials. The mean of 3 trials is calculated for anteroposterior stability index (APSI), mediolateral stability index (MLSI), and overall stability index (OSI) indexes, a higher score means excessive movement, and a lower score means better postural stability [21, 22]. If we held the cursor on the middle of the display grid, this indicated that the platform was held stable below to subject feet while keeping in a comfortable standing position [17].

***The Limits of stability test:***

The Test comprised of voluntary movement towards the targets which appear randomly on the front, back, right, and left side of a computer screen. These targets are arranged on the screen in a circular shape at angles of 45$^{o}$. Subjects were ordered to lean from the original central position towards each goal, thus representing the coincidence of the individual’s body mass center with the center of the platform [20]. For these trials, the feet were placed in the same position as for the postural stability test, and the test was done three times at a 10-second interval. Centering the participant again and telling him to attempt and move the cursor over the blinking target and to return to the center point as rapidly and with only a small deviation as possible. For each of the eight targets, the same procedure was repeated [17].

***The outcomes from tests include:***

-Overall Stability Index: reflects the ability of the subject to control its balance in all directions.

-Anterior/ Posterior Index: reflects the ability of the subject to control its balance in front to back directions.

-Medial/ Lateral Index: reflects the ability of the subject to control its balance from side to side.

-Limits of Stability: the maximum angle of your body can be reached from vertical without losing balance [17].

***Statistical analysis:***

-Descriptive statistics and t-test were conducted for comparison of the subject characteristics between groups A and B

-An unpaired t-test was conducted for comparison of cobb's angle between groups A and B.

-MANOVA was conducted for comparison of APSI, MLSI, OSI and limits of stability between groups A and B.

-The level of significance for all statistical tests was set at $p < 0.05$.

-All statistical measures were performed through the statistical package for social studies (SPSS) version 25 for windows.

## RESULTS

**- Comparison of cobb's angle between group A and B:**

There was a significant increase in the cobb's angle of group B compared with that of group A ($p = 0.0001$) (Table 1).

**-Effect of lumbar lordotic angles on dynamic postural stability and limits of stability:**

Multivariate Analysis of Variance (MANOVA) was conducted and found that there was a significant effect of lumbar lordotic angles on dynamic postural stability and limits of stability ($p = 0.0001$) (Table 2).

**-Comparison of overall stability index between group A and B:**

There was a significant increase in the overall stability index of group B compared with that of group A ($p = 0.0001$) (Table 3).

**- Comparison of anteroposterior stability index between group A and B:**

There was a significant increase in the APSI of group B compared with that of group A ($p = 0.0001$) (Table 4).

**- Comparison of mediolateral stability index between group A and B:**

There was a significant increase in the MLSI of group B compared with that of group A (p = 0.01) (Table 5).

### - Comparison of limits of stability between group A and B:

There was a significant decrease in the limits of stability of group B compared with that of group A (p = 0.0001) (Table 6).

**Table 1. Comparison of mean value of cobb's angle between group A and B:**

| | Group A | Group B | MD | t- value | p-value | Sig |
|---|---|---|---|---|---|---|
| | $\overline{X}$ ±SD | $\overline{X}$ ±SD | | | | |
| **Cobb's angle (degrees)** | 50.38 ± 4.34 | 66.89 ± 4.03 | -16.51 | -19.68 | 0.0001 | **S** |

**$\overline{X}$: Mean** **SD: Standard deviation** **MD: Mean difference**
**t value: Unpaired t value** **p value: Probability value** **S: Significant**

**Table 2. MANOVA for the effect of lumbar lordotic angles on dynamic postural stability and limits of stability:**

| **MANOVA** | |
|---|---|
| **Effect of lumbar lordotic angles on dynamic postural stability and limits of stability** | |
| $F_{(4,95)} = 11.91$ | $p = 0.0001$ |

**Table 3. Comparison of mean value of overall stability index between group A and B:**

| | Group A | Group B | MD | F- value | p-value | Sig |
|---|---|---|---|---|---|---|
| | $\overline{X}$ ±SD | $\overline{X}$ ±SD | | | | |
| **Overall stability index** | 1.42 ± 0.4 | 1.79 ± 0.35 | -0.37 | 23.88 | 0.0001 | **S** |

**Table 4. Comparison of mean value of anteroposterior stability index between group A and B:**

| | Group A | Group B | MD | F- value | p-value | Sig |
|---|---|---|---|---|---|---|
| | $\overline{X}$ ±SD | $\overline{X}$ ±SD | | | | |
| **Anteroposterior stability index** | 1.03 ± 0.34 | 1.42 ± 0.33 | -0.39 | 34.04 | 0.0001 | **S** |

**Table 5. Comparison of mean value of mediolateral stability index between group A and B:**

| | Group A | Group B | MD | F- value | p-value | Sig |
|---|---|---|---|---|---|---|
| | $\overline{X}$ ±SD | $\overline{X}$ ±SD | | | | |
| **Mediolateral stability** | **0.78 ± 0.23** | **0.91 ± 0.25** | **-0.13** | **6.29** | **0.01** | **S** |

| index | | | | | | |
|---|---|---|---|---|---|---|

**Table 6. Comparison of mean value of limits of stability between group A and B:**

| | Group A | Group B | MD | F- value | p-value | Sig |
|---|---|---|---|---|---|---|
| | $\overline{X}$ ±SD | $\overline{X}$ ±SD | | | | |
| **Limits of stability** | 53.62 ± 10.56 | 46.4 ± 6.2 | 7.22 | 17.36 | 0.0001 | **S** |

$\overline{X}$**: Mean** **SD: Standard deviation** **MD: Mean difference**

**p value: Probability value** **S: Significant**

# DISCUSSION

Results of our study revealed that there was a significant increase in the OSI, APSI, MLSI and decrease in the limits of stability of group B compared with that of group A, so subjects of group B have poorer balance.

There was a significant effect of lumbar lordotic angles on dynamic postural stability and limit of stability.

Maintaining balance is a dynamic process regulated by the central nervous system that influenced by vestibular, visual and multiple orthopedic disorders [23]. Several studies have shown that spinal deformities in children and young adults have a significant impact on balance, which is characterized by the postural index [24].

Bad posture is a common problem in children and young adults, and it has a negative effect in adulthood [25,26]. It is the most common two-dimensional spine deformity found in sagittal plane as thoracic kyphosis and lumbar hyperlordosis [27,28].

Many studies had shown a correlation between changes in lumbar curvature and worse balance test results and increased incidence of falls in healthy elderly. They proved that both thoracic hyperkyphosis and the loss of lumbar lordosis contribute to a change of the gravity line in the sagittal plane, decreasing stability limits in all directions in older adults [7].

The results of the current study were in agreement with a study conducted by Ishikawa et al. and Kasukawa et al. [29,30], that identified decreased spinal lordosis, decreased spinal range of motion, and back muscle weakness as critical factors for predicting falls.

Our results strengthened by Imagama et al. [31], who found that poor spinal sagittal alignment was linked to body imbalance, which partly due to the correlation of poor sagittal spinal alignment with falls.

The findings of the current study were matched with Drzał-Grabiec et al. [32], who found a strong link between body posture and the balance system response quality. The spinal curvature shape, using static posturography, affected postural stability.

The finding of the current study agreed with Sena et al. [22], that postural deformity could affect postural stability. They proved that postural stability and sensory integration in balance were altered in patients with ankylosing spondylitis.

The results of the present study were in accordance with those reported by Sung [33] who stated that belly abdomen contributes to increased lumbar lordosis and anterior shift of the center of gravity (COG). Because the deposition of adipose tissue in the abdomen raises the anterior tilt, body COG is pushed forward at the ankle joint. The results showed that in obese individuals, postural stability was lower.

In contrast, Nagymáté et al. [24], found in children with poor postures that the posture has not necessarily been significantly damaged since CNS is constantly correcting the effects of changing posture. Some variations in postural control could be established, but these differences are weakly explained. Bad posture correction is an essential physiotherapy process that should enhance posture and balance.

These findings were contradicted by Koura and El Shiwi [17], who carried out a study to evaluate postural stability in scoliotic female patients compared to normal subjects as a postural deformity. It was concluded that there were no alterations in postural stability in females with structural scoliosis relative to normal females, either in measuring the dynamic balance for APSI, MLSI and overall stability index, or measuring the limits of stability.

The current study was contradictory to a study was designed by Abdelrhman et al. [34], who found no relation between the postural changes in head region and dynamic balance using the biodex device for testing of dynamic balance and posture print software that was used for postural changes detections.

## Implementations:

- To advise on the prevention of postural deformity and to aid in lumbar problems assessment and balance problems considerations.
- This study is important to identify the relations between different segments and systems of the body.

## CONCLUSION

Based on the present data supported by relevant study, it is possible to conclude that the difference in lumbar lordotic angles affect dynamic postural stability and limits of stability in young adults. Therefore, subjects with hyperlordotic angles in the lumbar spine reported poor dynamic postural stability and decreased limits of stability than normal ones assessed by the biodex balance system.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest regarding this study.

## ACKNOWLEGEMENT

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## AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.

## Ethical approval

Ethical committee approval from the Faculty of Physical Therapy, Cairo University, Egypt (no:P.T.REC/012/002221) (in 3/2/2019) and a signed written consent forms with participants acceptance for participation in the study were obtained before starting the procedures.

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