Comparison of Lumbosacral Alignment Among Obese & Overweight Students

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Abstract

Objective: This study was designed to determine the relationship between Lumbosacral alignment & BMI of individuals.

Design: Cross- sectional study.

Setting: MGM School of Physiotherapy, Aurangabad.

Subjects: 70 Students aged between 18-25 years with BMI 25 and above.

Methodology: Participants were categorized as overweight or obese based on their BMI. Subsequently, they were instructed to expose their spines and stand erect with their feet apart. Utilizing a spinal mouse device, positioned along the contours of the participants' spines, readings were recorded on a computer screen through software provided by IDIAG.

Main outcome measure: Lumbosacral Angle, Lumbar lordosis angle, Sacral inclination angle.

Results: A significance level of $p < 0.05$ was chosen. The mean for LLA of overweight population was found to be 37.03 and SD was 6.05. While for obese mean was found to be 41.08 and SD 4.75. The P value for LLA is 0.001 which denotes significant difference between both the groups. The mean of SIA of overweight individuals was found to be 36.09 and SD of 3.77. For obese population mean was 41.11 and SD of 4.62. The P value for SIA is 0.001 which denotes significant difference between both the groups.

Conclusion: It is concluded that there is a significant difference in the Lumbar lordosis angle and Sacral inclination angle between Overweight & Obese adults; whereas no significant difference seen in Lumbosacral alignment between overweight and obese adults.

Keywords: Lumbosacral Angle, Lumbar lordosis angle, Sacral inclination angle, Spinal alignment, Spinal mouse, BMI.

INTRODUCTION:

The World Health Organization (WHO) delineates overweight, and obesity based on Body Mass Index (BMI), a crucial metric for characterizing adult anthropometric features[1]. Excessive adiposity characterizes these conditions, posing a significant public health challenge and exacerbating the burden of chronic ailments[2]. Co-morbidities like hypertension, diabetes mellitus, coronary artery

disease, menstrual irregularities, sleep apnea, and cancer are associated with these conditions[3]. Overweight is defined by a BMI of 25 or higher, while obesity is indicated by a BMI exceeding 30[4]. Both conditions elevate morbidity and mortality risks relative to individuals maintaining an ideal body weight. Obesity manifests in two primary body types: Gynoid, characterized by lower body fat accumulation, and Android, typified by upper body fat deposition, particularly in the visceral or abdominal regions[5].

Obesity significantly contributes to spinal disorders, including Low Back Pain (LBP) and reduced lumbar disc height, as well as increases perioperative complications during surgery[6]. There is a higher prevalence of overweight and obesity among females compared to males[7]. Numerous studies underscore the influential role of dietary patterns in BMI fluctuations[8]. Unhealthy eating habits and insufficient physical activity are recognized as primary drivers of obesity[9]. The majority of research findings establish a strong correlation between obesity and the risk of developing LBP and Arthralgia[10]. Musculoskeletal pain often leads to avoidance of physical activity, exacerbating weight gain[11]. Common complaints associated with multi-site pain include discomfort in weight-bearing joints such as the knee, ankle, foot, and back[12].

Obesity leads to joint pain, functional limitations, and walking difficulties. Reduced physical activity due to pain can exacerbate weight gain. Higher BMI individuals may experience musculoskeletal disorders, breathlessness, and joint pain during activity, negatively impacting their movement perception. Fear of movement due to pain correlates with injuries in those with LBP[13].

Spinal kinematics are essential for performing daily and locomotive activities. The cervical and thoracic vertebrae transmit their entire weight to the lumbosacral spine, where flexion, extension, and rotation movements occur. This region allows the greatest degree of mobility and is a common site of pain[14]. The lumbosacral joint is formed by the fifth lumbar vertebra and the first sacral segment, which forms an angle with the horizontal known as the lumbosacral angle[15]. Anterior tilting of the sacrum increases this angle, resulting in heightened shearing stress at the lumbosacral joint and potentially increasing anterior lumbar convexity while standing[16]. Lumbosacral alignment is crucial for proper spinal function[17]. Elevated BMI, especially in truncally obese individuals, may displace the sacrum base anteriorly, increasing the lumbosacral angle (LSA). This tilt induces greater SI joint flexion, heightening torque on the L5-S1 disc and shear forces, elevating disc degeneration risk. Thus, heightened LSA in obesity may increase LBP risk.[18]. An increase in the lumbosacral angle (LSA) heightens lower back pain (LBP) due to amplified shear forces at the lumbosacral junction. LBP patients adopt postures reducing lumbar lordosis (Lo) to alleviate pain, diminishing facet joint pressure and shear forces, weakening lumbar strength, and exacerbating pain by avoiding painful activities.[19].

Lumbar lordosis refers to the curvature adopted by the lumbar spine to counterbalance the sacral inclination, restoring an upright spinal posture and preventing forward tilting[20]. Influenced by factors such as age, gender, pelvic tilt, and thoracic curvature, abnormal posture strains soft tissues, weakens muscles, and alters lumbar lordosis[21]. The angle, formed by lines drawn through the superior end plate of L1 and the inferior plate of L5, increases with age[22]. Variations in this angle, influenced by pelvic position, affect lumbar curvature[23]. An increase in the angle heightens lumbar lordosis, intensifying shearing stress at the lumbosacral joint[24]. Normal lordosis safeguards spinal ligaments and absorbs shock from sudden forces. However, increased lordosis is a major source of pain, radiculopathy, and facet joint pain, while decreased lordosis angle contributes to lower back pain (LBP)[25]. Sitting shifts the pelvis backward, flattening lumbar lordosis and increasing spine pressure, potentially leading to LBP[26]. Age, gender, and changes in the center of mass (COM), as seen in pregnancy or obesity, influence lumbar lordosis. In response, excessive lordosis compensates for COM shifts, leading to hyperlordosis[27].

The sacrum, integral to the pelvis, forms an undistorted segment of the spinal curve and is pivotal in sagittal balance studies. Sacral inclination, indicating sacrum position, is crucial, particularly in describing lumbar spondylolisthesis[28]. Sacral surface may exhibit linear or slightly curved profiles, varying in curvature across its length, influencing lumbar spine positioning[29].

Sacral angle (SA) is potentially a risk factor for lumbosacral disc degeneration[30]. Sacral inclination angle (SIA) is the angle between a vertical plane and a tangential line to the posterior border of the S1 vertebra. Sacral inclination is categorized as dorsal inclination, the angle between a line parallel to

the back of the proximal sacrum and the horizontal plane, or cranial inclination, the angle between a line parallel to the upper endplate of the sacrum and the horizontal plane[31]. Overweight and obese individuals tend to exhibit higher SIA. Axial loading on the sacral base in this population may contribute to increased SIA and lower back pain (LBP)[32].

Several studies have documented an association between Body Mass Index (BMI) and Lumbar lordosis, revealing a significant correlation. Understanding the impact of overweight and obesity on the lumbosacral angle can provide insight into the controversial association between Low Back Pain and higher BMI. Therefore, this study aims to compare various lumbo-sacral alignment parameters, including Lumbosacral angle (LSA), Sacral Inclination Angle (SIA), and Lumbar lordosis angle (LSA), among overweight and obese individuals.

METHODS:

The study was conducted at the MGM School of Physiotherapy in Aurangabad, employing a non-experimental Hypothesis Testing design. It adopted an observational study approach and utilized simple random sampling to select a sample size of 70 subjects. Inclusion criteria comprised individuals aged 18-25 years, consenting to participation, and possessing a body mass index (BMI) of 25 and above. Conversely, exclusion criteria encompassed students with neurological or metabolic disorders, spinal injuries, deformities, prior history of spinal surgery, or lower limb deformities.

Participants were chosen according to predetermined inclusion and exclusion criteria, followed by an explanation of the procedure to them. Informed consent was obtained from each participant. They were then requested to measure their weight using a weighing machine, and their Body Mass Index (BMI) was calculated based on the obtained weights. Participants were categorized as overweight or obese based on their BMI. Subsequently, they were instructed to expose their spines and stand erect with their feet apart. Utilizing a spinal mouse device, positioned along the contours of the participants' spines, readings were recorded on a computer screen through software provided by IDIAG.

The gathered data was acquired using the spinal mouse device and analyzed utilizing IDIAG software. Mean and standard deviation (SD) were calculated for quantitative variables, while proportions were determined for categorical variables.

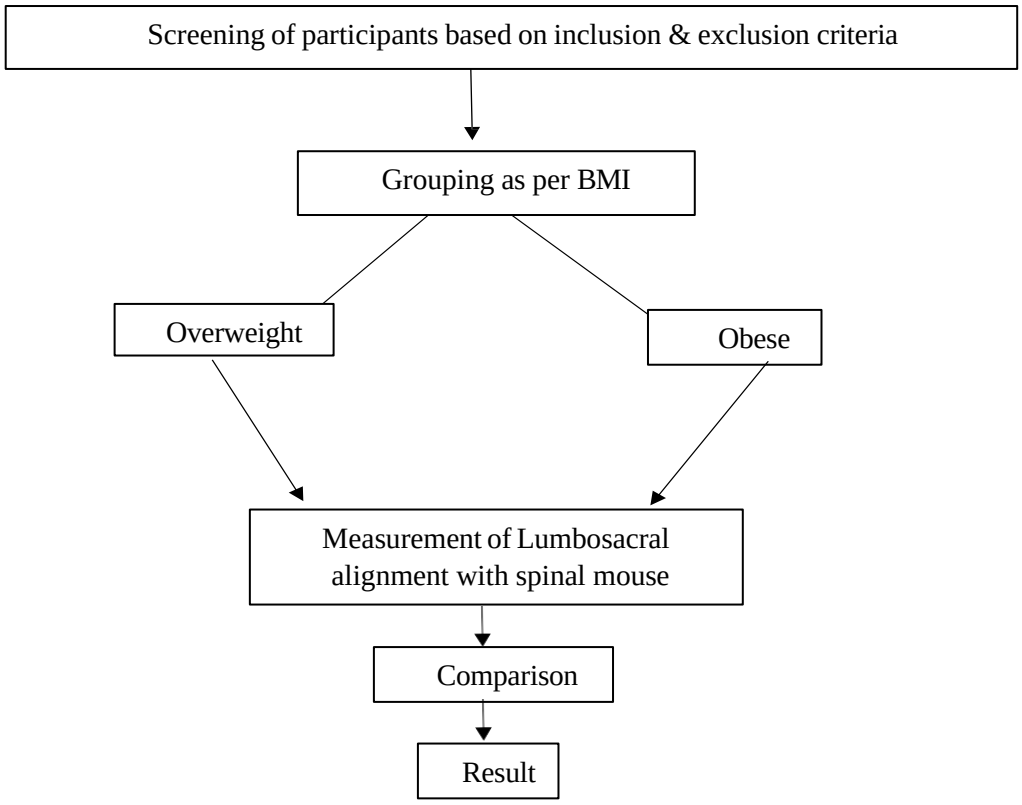


Fig. 1. Consort Chart of the study

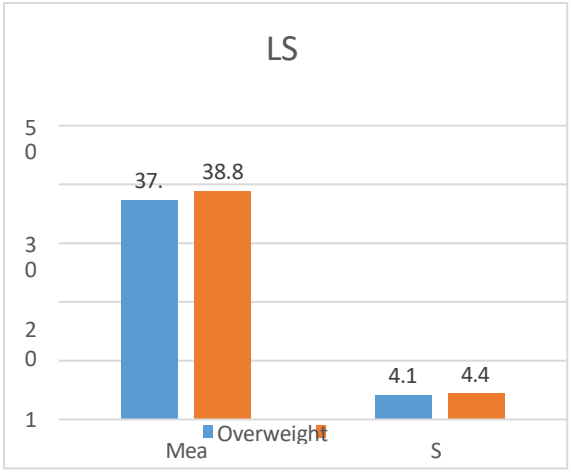
RESULTS:

In this study, 70 participants were included, comprising 35 overweight and 35 obese individuals. The aim was to compare lumbo-sacral alignment between overweight and obese adults. Data collected via the spinal mouse device was analyzed to generate results. Demographic characteristics were tabulated and presented using bar diagrams and tables. Standard deviation and percentage were utilized alongside mean values. A significance level of $p < 0.05$ was chosen.

The mean Lumbosacral Angle (LSA) for overweight individuals was 37.40 with a standard deviation of 4.16, and for obese individuals, it was 38.89 with a standard deviation of 4.47. The p- value for LSA was 0.155, indicating no significant difference between the two groups.

Variable	Group	Mean	SD	t-value	p-value
LSA	Overweight	37.40	4.16	1.439	0.155
	Obese	38.89	4.47		

Table 1: Lumbosacral angle (LSA)

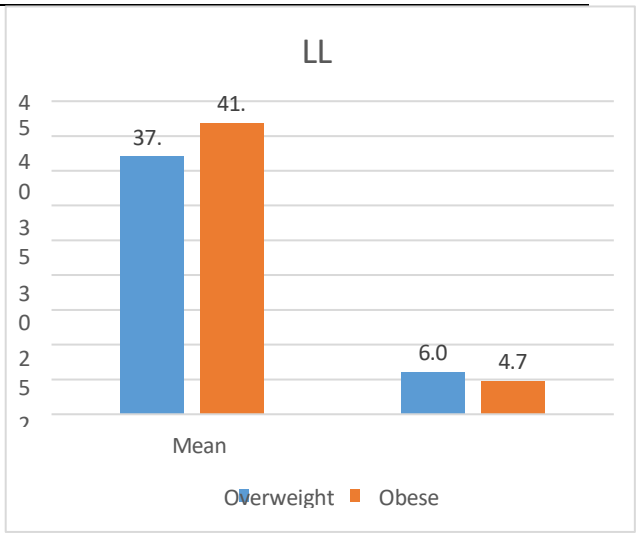


Graph 1: Lumbosacral angle (LSA)

The mean for LLA of overweight population was found to be 37.03 and SD was 6.05. While for obese mean was found to be 41.08 and SD 4.75. The P value for LLA is 0.001 which denotes significant difference between both the groups.

Variable	Group	Mean	SD	t-value	p-value
LLA	Overweight	37.03	6.05	3.669	0.001*
	Obese	41.80	4.75		

Table 2: Lumbar Lordosis Angle (LLA)

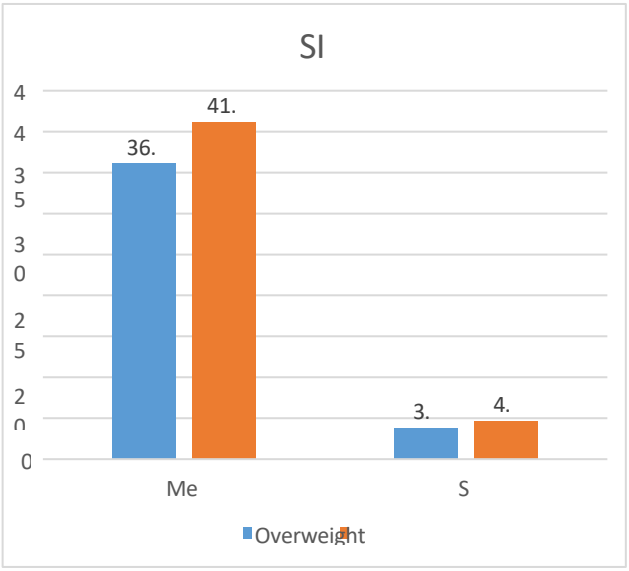


Graph 2: Lumbar Lordosis Angle (LLA)

The mean of SIA of overweight individuals was found to be 36.09 and SD of 3.77. For obese population mean was 41.11 and SD of 4.62. The P value for SIA is 0.001 which denotes significant difference between both the groups.

Variable	Group	Mean	SD	t-value	p-value
SIA	Overweight	36.09	3.77	4.990	0.001*
	Obese	41.11	4.62		

Table 3: Sacral Inclination Angle (SIA)



Graph 3: Sacral Inclination Angle (SIA)

DISCUSSION:

The primary objective of this study was to assess potential differences in lumbosacral alignment between obese and overweight individuals. Findings indicate that subjects with Obesity exhibit notably higher Lumbosacral Angle (LSA) compared to those

in Overweight category. This increase in LSA, particularly prominent in individuals with truncal obesity, may be attributed to the displacement of the sacral base anteriorly by the weight of the trunk. Consequently, anterior pelvic tilt induces greater flexion of the sacroiliac (SI) joints, resulting in increased torque on the L5-S1 disc. Elevated shear forces at this level may lead to disc overload, escalating the risk of disc degeneration. Consequently, the observed elevation in LSA among obese and overweight individuals may contribute to an increased susceptibility to lower back pain (LBP)[18]. Elevated Lumbosacral Angle (LSA) is implicated in the onset of lower back pain (LBP) due to heightened shear forces at the Lumbosacral junction. Consequently, individuals with LBP often adopt postures that reduce Lumbar lordosis (Lo) to alleviate pain, thereby diminishing pressure on facet joints and minimizing shear forces in the lumbosacral region[19]. An increase in Lumbar lordosis is observed in individuals with elevated BMI, such as those who are overweight or obese, as well as during pregnancy. In both scenarios, the center of mass (COM) of the trunk shifts forward, leading to increased movement at the hip joint. Consequently, the body reacts by excessively augmenting Lumbar Lordotic Angle (LLA) to counterbalance hip movement, thereby resulting in heightened lordosis[27].

Numerous studies have linked heightened Lumbar lordosis to lower back pain (LBP). Consequently, overweight and obese individuals typically exhibit increased lordosis. The study's results reveal a notable disparity in values between the two groups, indicating a significant difference. Therefore, individuals with elevated BMIs demonstrate heightened Lumbosacral Angle (LSA), whereas the observed variation between overweight and obese subjects is not statistically significant.

The magnitude of the angle is contingent upon pelvic positioning and impacts the overlaid lumbar curvature[23]. A surge in this angle leads to augmented lumbar lordosis, subsequently heightening shearing stress at the lumbosacral joint[24]. Increased lordosis emerges as a primary contributor to pain, radiculopathy, and facet joint discomfort[25].

Overweight and obese populations tend to exhibit higher Sacral Inclination Angle (SIA). Axial loading on the sacral base in obese and overweight individuals may account for the elevated SIA and subsequent lower back pain (LBP)[32].

Evcik and Yucel documented a higher Sacral Inclination Angle (SIA) in patients suffering from chronic Lower Back Pain (LBP). They observed an association between this angle and the maximal range of lumbar extension in both male and female patients.

According to our findings, a significant difference exists in the Sacral Inclination Angle (SIA) between overweight and obese individuals. Our study demonstrates the influence of increased BMI on Lumbosacral alignment. Elevated lumbosacral parameters were observed in Obese individuals compared to overweight individuals . However, no significant difference was detected between overweight and obese groups in terms of Lumbosacral Angle (LSA), while significant disparities were noted in Lumbar Lordosis Angle (LLA) and Sacral Inclination Angle (SIA) values.

In conclusion, according to the study findings, significant differences were observed between overweight and obese individuals in terms of Lumbar Lordosis Angle (LLA) and Sacral Inclination Angle (SIA). However, the differences in Lumbosacral Angle (LSA) between the two groups were found to be non-significant.

CLINICAL MESSAGES:

- **Clinical Implications**: Understanding the relationship between lumbosacral alignment and BMI can have important clinical implications for physiotherapists and healthcare professionals. It provides them with knowledge that can be used to develop more targeted interventions and treatment plans for individuals who are overweight or obese, particularly in managing and preventing musculoskeletal issues related to the spine.
- **Preventive Measures**: The findings of the study can be utilized to educate individuals about the potential impact of their BMI on their spinal health. This information can empower them to take proactive steps to maintain a healthy weight and reduce the risk of developing spinal problems associated with excess weight.
- **Research Direction:** The study adds to the body of research on the relationship between BMI and spinal alignment, contributing to a deeper understanding of the factors influencing spinal health. It may also inspire further research in this area, prompting additional studies to explore related variables or to replicate the findings in different populations.

- **Educational Value**: For students and researchers in the field of physiotherapy and related disciplines, this study provides educational value by demonstrating the methodology for assessing lumbosacral alignment and its association with BMI. It serves as a practical example of how research can be conducted to investigate clinical questions and generate evidence-based conclusions.

AUTHOR CONTRIBUTIONS

All authors have made substantial contributions to all of the sections below:

1. Conception and design of the study.
2. Data analysis and interpretation of data.
3. Final approval of the version to be submitted.

Specifics:

SS and KC: Conception and design, interpretation of data, Formation of manuscript; KB and TS: Data collection and Data analysis, DK: Statistical expertise; MP: Critical revision of the article for important intellectual content. All authors read and approved the final manuscript. The primary author: Siddique Shaikh and Karina Choudhary take the responsibility for integrity of the work as a whole, from inception to finished article.

CONFLICTS OF INTERESTS

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this study.

COMPETING INTEREST STATEMENT

The authors certify that the grant sponsor is not involved in study design, collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication.

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