

## **Association of Body Mass Index with Postural Stability and Functional Disability in Patients with Chronic Low Back Pain: An Observational Study**

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### **ABSTRACT**

**Background:** Chronic low back pain (CLBP) is a prevalent musculoskeletal ailment that causes significant disability and impairs quality of life. Recent literature demonstrates that a higher body mass index (BMI) reflects a higher functional disability, and postural stability also declines with increasing BMI.

**Objective:** This study examined the association of BMI with postural stability and functional disability in people with CLBP.

**Methods:** An observational cross-sectional study was conducted involving 73 participants aged 30–60 years with CLBP. Following World Health Organization (WHO) guidelines, BMI was recorded. Postural stability was assessed via the One Leg Stand Test (OLST) with eyes open and eyes closed, and via the Y-Balance Test–Lower Quarter (YBT-LQ). Functional disability was measured using the Modified Oswestry Disability Index (MODI). Data were analyzed with SPSS v20; Pearson correlation coefficients determined correlations between the variables.

**Results:** Results showed significant correlations. BMI was negatively correlated (eyes open:  $r = -0.651$ ; eyes closed:  $r = -0.622$ ; YBT-LQ:  $r = -0.602$ ;  $p < 0.01$ ) with functional disability ( $r = 0.562$ ;  $p < 0.01$ ). There was a significant correlation between functional disability and postural stability (eyes open:  $r = -0.667$ ; eyes closed:  $r = -0.715$ ; YBT-LQ:  $r = -0.893$ ;  $p < 0.01$ ).

**Conclusions:** Increased body mass is directly correlated to decrease in postural stability and increase in functional disability in CLBP patients. The strong association was found between balance and functional disability in CLBP patients.

**Key Words:** Chronic low back pain, Body Mass Index, Postural stability, Functional disability, Balance, Modified Oswestry Disability Index)

### **INTRODUCTION:**

Chronic low back pain (CLBP) is defined as pain lasting longer than 12 weeks. As one of the most common musculoskeletal disorders and leading cause of disability globally, CLBP affects not just physical functioning, but also problems with work productivity and increased healthcare usage, and poses an overall detriment to quality of life. The Global Burden of Disease 2021 report notes that more than 600 million people are affected by CLBP worldwide; projections estimate that it will increase again by the year 2050, which makes CLBP a pressing public health issue<sup>[1,2]</sup>.

Obesity, most commonly defined as having a body mass index (BMI) considered overweight or obese, is a major modifiable risk factor for CLBP[3,4]. It is a chronic condition characterized by excessive accumulation of body fat, typically resulting from an imbalance between energy intake and expenditure, and can be influenced by genetic, behavioral, and environmental factors. Obesity is classified using BMI, with values of 25–29.9 kg/m<sup>2</sup> suggesting overweight and ≥30 kg/m<sup>2</sup> suggesting obesity. Excess body weight exerts mechanical loading on the spine, promotes abnormal posture, can activate systemic inflammation, and reduces neuromuscular efficiency[5,6]. Research shows that individuals with excess body weight/degrees of obesity are more than two times as likely to develop or continue to have CLBP than individuals who are in the normal BMI category[7,8].

Postural stability, defined as the ability to maintain balance during static and dynamic activities, is another important variable in CLBP. Patients with CLBP typically exhibit increased postural sway and diminished sensation of self-movement, proprioceptive acuity and neuromuscular control<sup>[9,10]</sup>. Increased weight intensified the musculoskeletal performance functional impairment because of changes in the biomechanics of posture or limitations in postural control due to excessive weight<sup>[11,12]</sup>. These limitations in balance competency impact participation in daily life activities and add to the overall probability of falling and further worsening the disability associated with CLBP.

Functional disability is a characteristic aspect of CLBP. It highlights the extent to which pain motivates activity (walking, standing or self care). Multiple studies have detailed a strong association between lower balance scores and higher degrees of functional disability, demonstrating a clear functional decline due to poor postural stability<sup>[13,14]</sup>. Focusing on both postural stability and functional disability is further compounded by obesity by adding physical/bio-mechanical stress to an already challenging cycle of pain, reduced activity and further disability<sup>[15]</sup>.

While there has been prior investigation into BMI, postural stability, and functional disability in separate contexts, the combined interaction among these variables within patients with CLBP is poorly understood. Filling this gap is critical for providing strong clinical evidence to inform accurate and targeted rehabilitation protocols. A clear sense of these interrelationships will not only enhance clinical decision-making but also promote targeted interventions aimed at weight management, balance restoration, and recovery of functions.

## MATERIALS AND METHODOLOGY

**Study Design and Study Setting :** This study employed a cross-sectional observational design to evaluate the association between body mass index (BMI), postural stability, and functional disability in individuals with chronic low back pain (CLBP). The study was conducted in the outpatient physiotherapy department (OPD) of physiotherapy college and community of Ahmedabad city. The study protocol followed the terms of the declaration of Helsinki (2013 revision). Written informed consent was obtained from all the participants prior the study.

**Participants :** A total of 73 patients (calculated sample size was 65) diagnosed with CLBP, aged between 30 and 60 years, were recruited using a convenience sampling method.

### Inclusion criteria :

- Low back pain(LBP) > 12 weeks
- Non specific low back pain and/or mechanical in nature
- Both Gender
- NPRS score > 3

### Exclusion criteria :

- H/O Spine surgery or any Lower limb fracture more than 6 months
- Neural tissue involvement leading to radicular pain
- Any type of malignancy
- Any systemic diseases. Eg, Rheumatoid arthritis, Ankylosing spondylitis, etc.
- Vestibular dysfunctions

## Materials used for Data collection :

- ❖ Stadiometer
- ❖ Digital Weighing Scale
- ❖ Stopwatch
- ❖ Measure tape
- ❖ Red color tape
- ❖ Modified Oswestry Disability Index (MODI) Questionnaire

## PROCEDURE

There were 73 chronic low back pain (CLBP) participants enrolled in the study who met the inclusion criteria. Demographic data on age, sex, work occupation, and education level was obtained on the demographic data collection form. The height and weight of the participants were measured by researcher using a stadiometer and a standard digital weigh-scale and the body mass index (BMI) was calculated according to the World Health Organization (WHO) guidelines. Participants completed the One Leg Stand Test (OLST) with their eyes-open and eyes-closed, Y-Balance Test-Lower Quarter (YBT-LQ) with overall reach distances normalized to limb length, and composite score was calculated. Modified Oswestry Disability Index (MODI) was used to measure functional disability. The MODI is a validated questionnaire used for the assessment of disability in CLBP participants. All prospective procedures were conducted under controlled and standard conditions, with the assurance of participant confidentiality throughout the study.

## Outcome Measures

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**1. Body Mass Index (BMI):** Height and weight were measured through a stadiometer and electronic scale by the researcher and BMI was assessed as weight (kg)/height ( $m^2$ ). WHO guidelines were used for classification<sup>[16]</sup>.

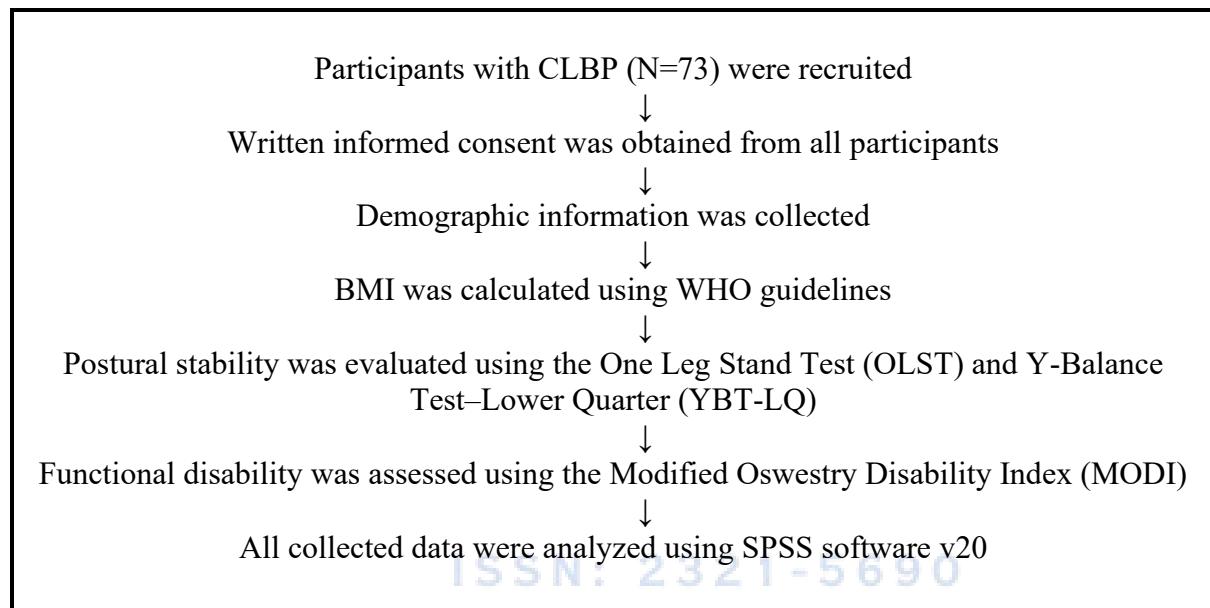
**2. Postural Stability:** Static balance was measured for postural stability via One Leg Stand Test (OLST), and dynamic balance via Y-Balance Test-Lower Quarter (YBT-LQ) with distance reached normalized for limb length.

**One Leg Stand Test (OLST):** OLST was used to measure static postural stability. The participants stood barefoot on a flat surface with the relaxed arms and raised one leg off the ground without putting it on the standing leg. OLST was conducted in two conditions: eyes open (looking at an object straight ahead) and eyes closed. Timing began when the foot was lifted and stopped when the subject lost balance (the foot hit the ground, the arms reacted, or the standing leg shifted). All conditions were done three times with the best time (in seconds) for each. Each subject received a 30-second break between trials. The OLST is reliable and valid for assessing balance for musculoskeletal disorders, such as CLBP<sup>[17]</sup>.

**Y-Balance Test-Lower Quarter (YBT-LQ):** In the YBT-LQ, participants stood on a stance platform equipped with three measuring arms that extended in the anterior, posteromedial, and posterolateral planes of movement. Participants stood barefoot on the midpoint of the stance platform with their hands on the hips. While maintaining the standing balance position, participants reached with their free limb in each of the three directions and pushed the reach indicator as far as they felt possible. Participants then returned to the starting position. There were six practice trials and three trials that were recorded for each limb, with a 30-sec rest between trials. Reach distances were recorded and measured in centimeters, and then were normalized to limb length (anterior, posteromedial, and posterolateral reach  $\div$  limb length  $\times$  100). The composite score was calculated using the following formula: (anterior + posteromedial + posterolateral reach  $\div$  3  $\times$  limb length)  $\times$  100. If the participant lost their balance, shifted weight onto the stance limb, or their foot did not return properly to the starting position, participants were instructed to repeat their trial. The YBT-LQ has been found to be a reliable and valid measure of dynamic postural stability and performance with functional tasks in musculoskeletal populations<sup>[18,19]</sup>.

**3. Functional Disability:** The Modified Oswestry Disability Index was used to measure the functional disability. The index includes ten sections or parts related to pain, functions and restrictions with or during

daily activities including sitting, standing, walking, and lifting. Each section is scored 0 (no disability) to 5 (maximal of disability) and calculated out of 100 percent. Disability categories were minimal (0% - 20%), moderate (21% - 40%), severe (41% - 60%), crippled (61% - 80%), or bedbound or exaggerated (81% - 100%). The Modified Oswestry Disability Index has been validated and established reliability evidence for patients with chronic low back pain<sup>[20,21]</sup>.



**Figure 1. Procedure of the study**

## STATISTICAL ANALYSIS

Statistical analysis was conducted with SPSS version 20. Descriptive statistics, consisting of mean and standard deviation, were calculated to describe demographic and clinical variables. Normality of the data was checked using Shapiro-Wilk test. The relationship between body mass index (BMI) and postural stability measures, in addition to functional disability, was calculated through Pearson's correlation coefficient ( $r$ ). The significance for statistical purposes was set at  $p < 0.05$ .

## RESULTS

Total 73 adults were studied. Descriptive statistics as shown in Table 1.

**Table 1: Descriptive characteristics of outcome measures**

Outcome Measures	N	Minimum	Maximum	Mean $\pm$ SD
BMI (kg/m <sup>2</sup> )	73	18.8	33.6	24.98 $\pm$ 3.42
OLST - EO (s)	73	27	47	36.35 $\pm$ 4.79
OLST - EC (s)	73	16	30	22.82 $\pm$ 3.64
YBT-LQ Composite Score (cms)	73	61	100	84 $\pm$ 7.88
mODI (%)	73	18	42	25.12 $\pm$ 4.74

Abbreviations : **OLST** – One Leg Stand Test, **EO** – Eyes Open, **EC** – Eyes Closed, **YBT-LQ** – Y-Balance Test–Lower Quarter, **mODI** / **mODI** – Modified Oswestry Disability Index

**Table 2. Pearson Correlation between outcome measures**

Outcome Variables	r-value	p-value
BMI - Static balance [Eyes Open (EO)]	-0.651	<0.01*
BMI - Static balance [Eyes Closed (EC)]	-0.622	<0.01*
BMI - Dynamic balance [(YBT-LQ Composite score)]	-0.602	<0.01*
BMI - Functional disability [mODI]	0.562	<0.01*
Static balance [Eyes Open (EO)] - Functional disability [ mODI ]	-0.667	<0.01*
Static balance [Eyes Closed (EC)] - Functional disability [ mODI ]	-0.715	<0.01*
Dynamic balance [(YBT-LQ Composite score)] - Functional disability [ SmODI ]	-0.893	<0.01*

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**Abbreviations :** **OLST** – One Leg Stand Test, **EO** – Eyes Open, **EC** – Eyes Closed, **YBT-LQ** – Y-Balance Test–Lower Quarter, **MODI / mODI** – Modified Oswestry Disability Index. (\* shows level of significance)

Data was normally distributed. Pearson's correlation analysis indicated significant associations between BMI, balance measures, functional disability, and dynamic postural stability, as can be seen in (Table 2) ( $p < 0.01$  for all). A higher BMI displayed a moderate negative correlation with balance in both the eyes open ( $r = -0.651$ ) and eyes closed ( $r = -0.622$ ) assessments, as well as negative correlation with the YBT-LQ composite ( $r = -0.602$ ), which demonstrated that an increase in BMI was associated with poorer balance and resulted in poor dynamic postural control. Contrarily, increased BMI exhibited a positive correlation with the mODI ( $r = 0.562$ ), indicating that increase in BMI were related to increase in functional disability.

Furthermore, balance measures (EO and EC) displayed significant negative correlations with the mODI ( $r = -0.667$  and  $r = -0.715$ ), which suggested that impairments in balance may be related to greater levels of disability. The strongest negative correlation occurred between the YBT-LQ composite and the mODI ( $r = -0.893$ ), which showed that decreased dynamic postural stability was highly correlated with greater levels of functional disability exhibited in individuals with CLBP.

## DISCUSSION

The present research demonstrated that higher BMI was significantly associated with impairments in balance under both eyes-open and eyes-closed conditions, as well as lower performance on the YBT-LQ composite score. BMI was also correlated with the mODI, and the correlation was positive, meaning that subjects with higher BMI perceived more disability. Moreover, balance impairments were inversely correlated to disability, with the highest degree of correlation being between YBT-LQ composite score and mODI. These findings show that elevated BMI is a factor that is correlated with poorer postural stability and impairment in function in CLBP patients.

The results of the present study were strongly supported by previous studies. Alshahrani et al. (2025) have shown that BMI and disability plays a significant role in postural stability in CLBP patients, which supports our research and confirms that being overweight not only impairs balance but also enhances functional disability in such patients<sup>[5]</sup>. Kruse et al. (2025) also showed that high BMI reduces postural control in normal adults, supporting the suggestion that more body mass per se, regardless of pathology, reduces stability and

postural adaptation<sup>[22]</sup>. Almurdi et al. (2024) reported decreased postural stability in overweight individuals, consistent with decreased dynamic stability in the present study, further supporting BMI as a significant factor in neuromuscular control<sup>[23]</sup>. Mikkonen et al. (2025) also highlighted that impairment in movement control in CLBP is correlated with disability and BMI, further supporting evidence of higher body mass exacerbating motor impairment in chronic pain states<sup>[24]</sup>. Again, Guzmán-Muñoz et al. (2025) confirmed that dynamic balance in young adults is greatly affected by BMI and nutritional status, corroborating our finding of decreasing YBT-LQ scores with rising BMI<sup>[25]</sup>.

The evidence is also in favor of the relationship between balance deficits and disability. Elabd et al. (2024) identified that BMI and clinical parameters were robust predictors of disability in patients with back pain and reiterated the interrelatedness of body composition, balance, and functional impairment<sup>[26]</sup>. Rabieezadeh et al. (2024) showed that postural control treatment like dynamic neuromuscular stabilization alleviated pain and disability in CLBP, indirectly validating that disrupted balance mechanisms are the cause of functional disability<sup>[27]</sup>. Alshahrani et al. (2025) also showed increased postural sway and poor balance in CLBP patients versus healthy controls, providing further validation for our finding of deficits of balance within this group<sup>5</sup>. In like manner, Aydogan et al. (2024) reported that BMI adversely affected balance, endurance of core muscles, and mobility among students, suggesting that increased BMI reduces both static and dynamic functional capacities<sup>[28]</sup>. Narciso et al. (2023) also noted that postural control among overweight women was impaired, which mirrors the strong inverse correlation we established between YBT-LQ and mODI, reflecting the combined effects of excess weight on disability and stability<sup>[29]</sup>.

Collectively, these studies reaffirm the present findings and highlight that BMI, balance, and functional disability are interrelated. The uniformity of the evidence across populations, ranging from healthy adults to those afflicted with CLBP, confirms the robust character of this relationship and emphasizes that the application of BMI and postural stability should be considered as key factors in managing functional outcomes in chronic low back pain.

## **CONCLUSION**

This study found that higher BMI in individuals with CLBP was significantly associated with impaired static balance (eyes open and closed), reduced dynamic stability (YBT-LQ composite score), and greater disability (mODI). Strong negative correlations between balance measures and disability further indicated that poorer postural stability contributes to functional limitations. These findings emphasize the need for weight management and balance-focused rehabilitation to improve stability and reduce disability in CLBP patients.

## **LIMITATION OF THE STUDY**

**Lack of longitudinal follow-up** – The study did not track changes over time, so the long-term influence of BMI on stability and disability remains unknown.

## **FUTURE RECOMMENDATIONS**

Lower limb dominance can be found and compare with the performance of both lower limb, The study can include weight management and balance exercises in rehabilitation and the study can be conducted that includes personalized treatment plans based on BMI and stability.

## **ABBREVIATIONS**

- **BMI** – Body Mass Index
- **CLBP** – Chronic Low Back Pain
- **LBP** – Low Back Pain
- **WHO** – World Health Organization

- **OLST** – One Leg Stand Test
- **EO** – Eyes Open
- **EC** – Eyes Closed
- **YBT-LQ** – Y-Balance Test–Lower Quarter
- **MODI / mODI** – Modified Oswestry Disability Index
- **NPRS** – Numerical Pain Rating Scale
- **OPD** – Outpatient Department
- **SPSS** – Statistical Package for the Social Sciences

**CONFLICT OF INTEREST:** The authors confirm that there are no potential conflicts of interest.

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