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INFLUENCE OF LOWER EXTREMITY MALALIGNMENTS ON MOVEMENT KINEMATICS AND DISABILITY IN ACUTE VS. CHRONIC LOW BACK PAIN PATIENTS

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Abstract

Background: Low back pain (LBP) is one of the leading causes of disability worldwide. Lumbar biomechanics may be impacted by lower extremity malalignments like pes planus, genu varum, genu valgum, and limb length discrepancy, leading to discomfort and disability. However, there is limited information on the comparison of movement kinematics and impairments between acute and chronic LBP. Objectives: This study examined lower-extremity alignment, movement kinematics, lumbar range of motion (ROM), pain severity, and functional impairment in individuals with both acute and chronic low back pain. Methods: This cross-sectional study included 50 participants, divided into two equal groups: 25 with acute low back pain and 25 with chronic low back pain, all aged 18–25 years and recruited through convenience sampling. Outcome measures included the Visual Analog Scale (VAS), Oswestry Disability Index (ODI), Roland–Morris Disability Questionnaire (RMDQ), lumbar range of motion (ROM) assessed with a goniometer, and a composite functional movement score. Group differences were analyzed using independent samples t-tests. Outcomes: Individuals with long-term low back pain (LBP) reported far more pain. (VAS: 6.92 ± 3.04 versus 5.24 ± 1.61; p = 0.018), increased disability (ODI: 23.84 ± 7.80 compared to 17.96 ± 5.79; p = 0.004; RMDQ: 12.24 ± 3.06 versus 9.92 ± 3.40; p = 0.015), greater restriction in range of motion (10.32 ± 2.82 versus 8.56 ± 2.72; p = 0.030), and poorer functional performance (16.28 ± 4.18 compared to 12.92 ± 3.29; p = 0.003) than those with acute LBP. In conclusion, chronic LBP is associated with increased pain, disability, and movement impairments. Malalignments in the lower extremity might contribute to these effects.

INTRODUCTION

Low back pain is a leading cause of years lived with disability and a major global health concern. (1). It is a widespread problem affecting people of all ages and occupations, with significant consequences. While spinal issues are the primary cause of back pain, recent rehabilitation research also emphasizes the biomechanical role of the lower extremities in influencing lumbar stress and pain (2).

Lower limb malalignments include conditions such as pes planus, pes cavus, genu varum, genu valgum, limb length discrepancies, and pelvic obliquity, can significantly alter the kinetic chain that extends from the foot to the lumbar area. The kinetic chain is the arrangement of interrelated links and motions through the whole kinetic system, and the malalignments in the lower extremities have the capacity to impact the lumbar area, the ground response force, and the lumbar vertebrae and intervertebral discs (3).

Estimates from the Global Burden of Disease Study and the World Health Organization indicate that approximately 619 million people worldwide were affected by low back pain in 2020, with projections suggesting this figure could increase to around 843 million by 2050. (4). The global prevalence rate is approximately 7–8% of the population at any time (5). A GBD-based study from Pakistan in 2025 reported a prevalence of 7,462 cases per 100,000 people in 2021 (~7.4%), compared to 6,500 per 100,000 (~6.5%) in 1990. This indicates a 14.8% rise over the years. The data suggest that about 7–8 out of every 100 individuals in Pakistan currently suffer from LBP (6).

LBP is a complicated disorder that is impacted by a number of variables, including occupational, psychological, neuromuscular, and anatomical aspects. Over the past two decades, the understanding of low back pain has changed significantly, recognizing that spinal issues alone cannot fully explain the disability associated with it. The connection between biological, psychological, and social elements that impact health is currently highlighted by the well-recognized biopsychosocial model. The impact of lower limb misalignment on LBP is well established. For example, Anterior pelvic tilt and increased femoral internal rotation can be caused by genu valgum, or knock knees. Hyperextension may result from this extra strain on the lumbar erector spinae (7). Similarly, pes planus (flatfoot) reduces the foot's ability to absorb shock, increasing stress transfer along the kinetic chain and potentially raising compressive forces on the lumbar spine. Even minor limb length discrepancies might cause compensatory scoliosis and lead to overactivation of muscles on one side(8).

This progression from acute to chronic LBP is associated with specific neuromuscular control adaptations. The neuromuscular adaptations associated with chronic pain states include altered motor recruitment patterns in the lumbar multifidus and transversus abdominis muscles, delayed postural reflexes, and diminished sensory acuity (9, 10). These factors contribute to the mechanical disadvantage associated with lower extremity malalignment, thereby forming a self-reinforcing cycle. Reliable instruments for assessing LBP pain and impairment include the VAS, the RMDQ, and the ODI. The ODI has high reliability coefficients (ICC > 0.90) in measuring disability associated with LBP. Goniometric measurement of lumbar ROM, though operator specific, is a useful tool for obtaining objective data when uniform procedures are employed. Functional movement analysis, including sit-to-stand, forward bending, and fingertip-to-floor measurements, is useful for determining the patient's neuromuscular and biomechanical capabilities (11). These measurements, along with structural alignment analysis, give a complete picture of the patient's functional state. Past studies have shown a significant correlation between decreased lumbar ROM, poor functional movement analysis, and disability ratings in individuals with long-term LBP. A distinction considered critical but insufficiently explored in the existing literature on LBP is the comparison between acute and chronic presentations. While acute presentations, or back pain lasting shorter than six weeks, are associated with well-maintained neuromuscular function, chronic presentations, or back pain persisting for more than 12 weeks is associated with neuromuscular dysfunction, central sensitization, psychosocial stress, and physical deconditioning (12). The question of whether malalignment in the

lower extremities could have differential effects on the two populations, particularly regarding movement kinematics, ROM, and disability, is considered an important question (13).

This study aimed to compare patients with acute and chronic low back pain in terms of lower extremity malalignment, lumbar movement kinematics, pain intensity, and functional impairment.

The results are considered important for informing physiotherapy assessment and for developing individually tailored, biomechanically based rehabilitation strategies (14, 15).

Objectives

The current study's goals were to:

- To examine lower extremity alignment patterns in patients with acute and chronic low back pain.
- Compare lumbar movement kinematics and range of motion between the two groups
- Assess and compare the functional disability levels using standardized outcome measures.
- Compare the levels of pain intensity.
- Investigate the relationship between the malalignment and movement dysfunction.
- Identify the potential biomechanical risk factors that could contribute to increased levels of disability.

Rationale of the Study

While the incidence rates of both LBP and lower extremity structural anomalies are high, few studies examine their combined effect in acute versus chronic populations (16). The importance of the relationship between the two conditions is highlighted by the potential implications that, if structural malalignments are found to have a major part in the disability associated with chronic LBP, then the implementation of early malalignment screenings in acute LBP patients could prove to be an important preventive measure (17).

Research Question

Do patients with chronic LBP show increased levels of disability, pain, and movement restrictions related to malalignment in the lower extremities compared to individuals having acute LBP?

Hypothesis

Null Hypothesis (H_0): Patients with acute and chronic low back pain do not significantly differ in terms of pain, disability, and lumbar mobility.

Alternative Hypothesis (H_1): Significant differences exist in pain, disability, and lumbar movement between patients with acute and chronic LBP who have lower extremity malalignment.

Impact and Study Gap

This research contributes to an increasing body of research evidence that links peripheral biomechanical factors with disability progression in lumbar disorders. Physiotherapy interventions currently target the lumbo pelvic region, with little emphasis placed on the role of the lower extremities. By demonstrating significant between group differences in disability and kinematic outcomes, this research emphasizes the importance of including the lower extremities in standard LBP interventions.

Material and Methodology

Design of Study

The study used a cross-sectional comparative design to assess lower extremity malalignment, lumbar kinematics, and disability in two groups of patients with low back pain. The cross sectional design was considered appropriate for establishing baseline differences between groups and for investigating relationships between structural factors and outcomes in a clinically feasible manner.

Duration of Study

The data collection process was carried out from 3rd February to 2nd March 2026. Participants were recruited consecutively, and once the sample size was obtained, data collection was stopped.

Inclusion Criteria

The following were the requirements for inclusion:

- Participants must be between the ages of 18 and 25.
- The participant must be experiencing LBP.
- The participant must be classified as either acute or chronic according to the operational definitions of pain duration less than 6 weeks or more than 12 weeks, respectively.
- The participant must be able to give written consent.

- The participant must be able to carry out all the procedures independently.

Exclusion Criteria

The exclusion criteria were:

- The participant must not have a history of back or lower limb surgery.
- The participant must not have confirmed neurological disorders.
- The participant must not have acute fractures or bone pathology.
- The participant must not be pregnant.
- The participant must not have systemic inflammatory disease.
- The participant must not be receiving active physiotherapy treatment for back pain.

Outcomes Measured

The following outcome domains were measured:

- Pain intensity (VAS).
- Functional disability (ODI, RMDQ).
- ROM in the lumbar region (goniometric measurements in flexion, extension, lateral bending, and rotation).
- Functional movement (forward bending test, fingertip to floor test, and sit to stand test).
- Lower extremity alignment (knee alignment, foot posture, limb length, and pelvic symmetry).

Scales and Tools

The Visual Analog Scale (VAS) consists of a straight horizontal line used to assess pain intensity, anchored by "no pain" at one end and "worst imaginable pain" at the other. It has shown excellent test–retest reliability in individuals with low back pain, with an intraclass correlation coefficient (ICC) of 0.97 (18). The ODI is a self-administered questionnaire made up of ten items that assess disability related to pain. It covers key areas such as personal care, lifting, walking, sitting, standing, sleeping, social activities, and travel. (19). The RMDQ is a 24-item instrument designed to evaluate the impact of low back pain on an individual's ability to perform daily activities. (20). A goniometer was used to measure ROM, even though it was expressed in degrees. Although ROM was measured in degrees, results were converted into a standardized ordinal restriction score (0–3 per movement), and summed to obtain a composite The range-of-motion (ROM) limitation score incorporates key spinal movements, including rotation (approximately 5–10°), flexion (40–60°), extension (20–35°), and lateral bending (15–20°). Each movement was rated on a 0-3 ordinal scale based on the percentage of normal movement observed. Forward Bending Test: This test was used to assess compensation mechanisms, pain perception, and movement smoothness (21). Fingertip to Floor Test: This test calculates the greatest forward bending distance between the fingertips and the floor (22). The Sit to Stand Test assesses a person with LBP's capacity to rise from a regular chair without moving their arms (23, 24).

Procedure

All assessments were conducted by a physiotherapist trained for this study. Here, demographic data and clinical history information were collected. Then, all participants completed the VAS, ODI, and RMDQ. Alignment of the lower extremities was assessed by clinical observation using a standard screening form. Goniometric assessment was carried out in a consistent sequence, beginning with flexion and extension, followed by lateral flexion to both sides and then rotational movements. After these measurements, functional tasks were evaluated in order, including forward bending, the finger-to-floor test, and the sit-to-stand movement.

Data Analysis

Data analysis was performed using IBM SPSS Statistics. Descriptive statistics were calculated, including mean, standard deviation, median, and range. Group differences were examined using an independent samples t-test based on mean values. Statistical significance was set at a threshold of $p < 0.05$. The results are presented with corresponding t-statistics and p-values in the table below, where $p < 0.05$ indicates significance, $p < 0.01$ denotes high significance, and NS represents non-significant findings.

RESULTS

Demographic Characteristics

There were fifty individuals, twenty-five of whom were added to Group 1 for acute LBP and twenty-five to Group 2 for chronic LBP. Table 1 displays the demographic features. The age distributions of the two groups were comparable, with Group 1 at

21.36 ± 1.91 years and Group 2 at 21.48 ± 2.12 years (p = 0.835). There were more men in the acute group (64.0%) than in the chronic group (44.0%), whereas more women in the chronic group (56.0%).

Table 1: *Study Participants' Demographic Features*

Characteristic	Group 1 (Acute LBP) n = 25	Group 2 (Chronic LBP) n = 25
Sample Size	25	25
Male	16 (64.0%)	11 (44.0%)
Female	9 (36.0%)	14 (56.0%)
Age (Mean ± SD)	21.36 ± 1.91	21.48 ± 2.12
Age Range (years)	18–25	18–25

Descriptive Analysis and Comparisons Between Groups

Table 2 presents the descriptive statistics, the findings of the independent samples t-tests for each outcome measure. All outcome indicators showed significant between-group differences, with the exception of age, indicating comparability of baseline demographic data while revealing differential clinical profiles.

Table 2: ***Descriptive Statistics and Between Group Comparisons (Acute vs. Chronic LBP)***

Variable	Group 1 Mean ± SD	Median	Range	Group 2 Mean ± SD	Median	Range	t-stat	p-value
Age (years)	21.36±1.91	21.00	18–25	21.48±2.12	21.00	18–25	-0.210	0.8346 NS
VAS Score	5.24±1.61	6.00	2–8	6.92±3.04	6.00	3–19	-2.440	0.0184
ODI (%)	17.96±5.79	18.00	4–27	23.84±7.80	25.00	3–45	-3.025	0.0040
RMDQ Score	9.92±3.40	11.00	3–15	12.24±3.06	13.00	6–19	-2.535	0.0145
ROM Restriction Score	8.56±2.72	9.00	0–14	10.32±2.82	9.00	5–16	-2.242	0.0296
Functional Total	12.92±3.29	14.00	4–18	16.28±4.18	17.00	8–23	-3.159	0.0027

$p < 0.05$, $p < 0.01$, and NS = Not Significant are the significance codes. Visual Analog Scale (VAS); ODI = Oswestry Disability Index; Roland-Morris Disability Questionnaire (RMDQ); Lumbar Motion Range (composite score).

Pain Intensity (VAS)

Significant differences were found in pain intensity levels, with chronic LBP patients having higher pain intensity levels than acute LBP patients. Pain intensity was higher in chronic LBP patients (mean 6.92 ± 3.04) than in acute LBP patients (5.24 ± 1.61). With a t-value of -2.440, the difference was statistically significant (p = 0.018).). The higher standard deviation in pain intensity levels among chronic LBP patients indicates greater variability in pain perception among chronic LBP patients.

Functional Disability

A statistically significant difference was observed between the two groups based on the t-test results (t = -3.025, p = 0.004). People with chronic LBP scored higher on the Oswestry Disability Index than people with acute LBP. (23.84 ± 7.80), substantial disability, compared to (17.96 ± 5.79), minimum to moderate disability). Additionally, the RMDQ revealed significant Differences between the two groups suggest that patients with chronic low back pain exhibit distinct outcomes had a high degree of physical activity limitations (12.24 ± 3.06).

Lumbar Range of Motion

The composite lumbar range of motion (ROM) restriction score was higher in the chronic low back pain group compared to the acute low back pain group (10.32 ± 2.82 vs 8.56 ± 2.72). The difference

between the two groups was statistically significant, with a t-value of -2.242 and a p-value of 0.030.

Composite Functional Movement Score

With a computed t-value of -3.159 and a probability level of 0.003, the composite functional movement score which includes lumbar range of motion, forward bending, fingertip to floor, and sit to stand was the highest score for between group difference in this study. With a composite functional movement score of 16.28 ± 4.18, the chronic LBP patient group was classified as having moderate to severe impairment, whereas the acute LBP patient group scored 12.92 ± 3.29.

Graphical Representation

Comparison of Outcome Measures between Acute and Chronic LBP Groups

Figure 1, the mean values for the different tests carried out on both acute and chronic LBP are directly compared. Patients with chronic LBP have higher mean values compared to those with acute LBP. This indicates greater pain, disability, and reduced mobility in patients with chronic low back pain.

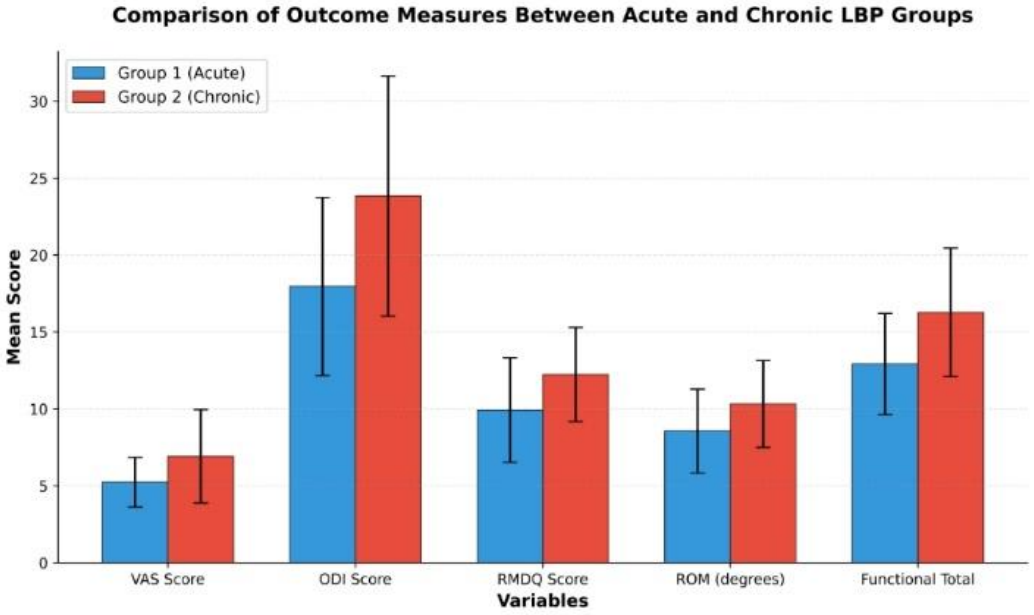

Figure 1 Comparison bar char of outcome measures between groups

Distribution of Outcome Measures by Groups

Figure 2 shows Box plots that reveal information about the dispersion of results, including median values, quartiles, and potential outliers, for both conditions. Chronic LBP patients have a larger range, indicating greater dispersion in their clinical findings. The higher median values in chronic cases further highlight their seriousness.

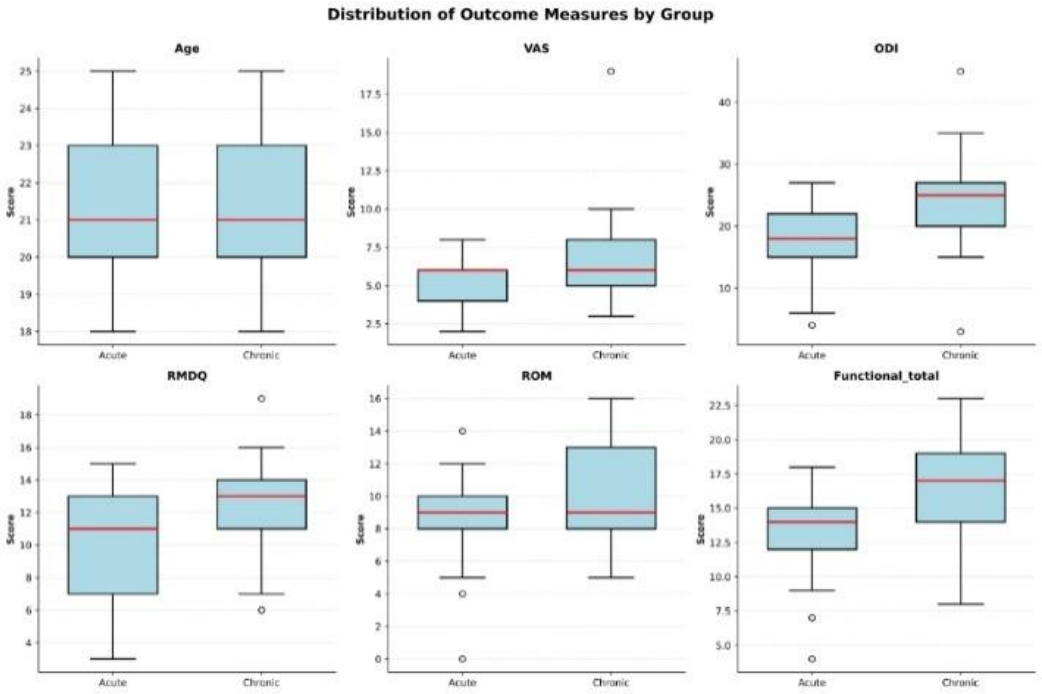

Figure 2 presents box plots illustrating the distribution of outcome measures across the study groups.

Correlation Analysis between Outcome Measures

In Figure 3, the graphs plotted against the regression line indicate how clinical factors such as pain, disability, and range of motion correlate with one another. A positive relationship exists between pain and functional disability. In addition, restricted range of motion is also associated with increased disability.

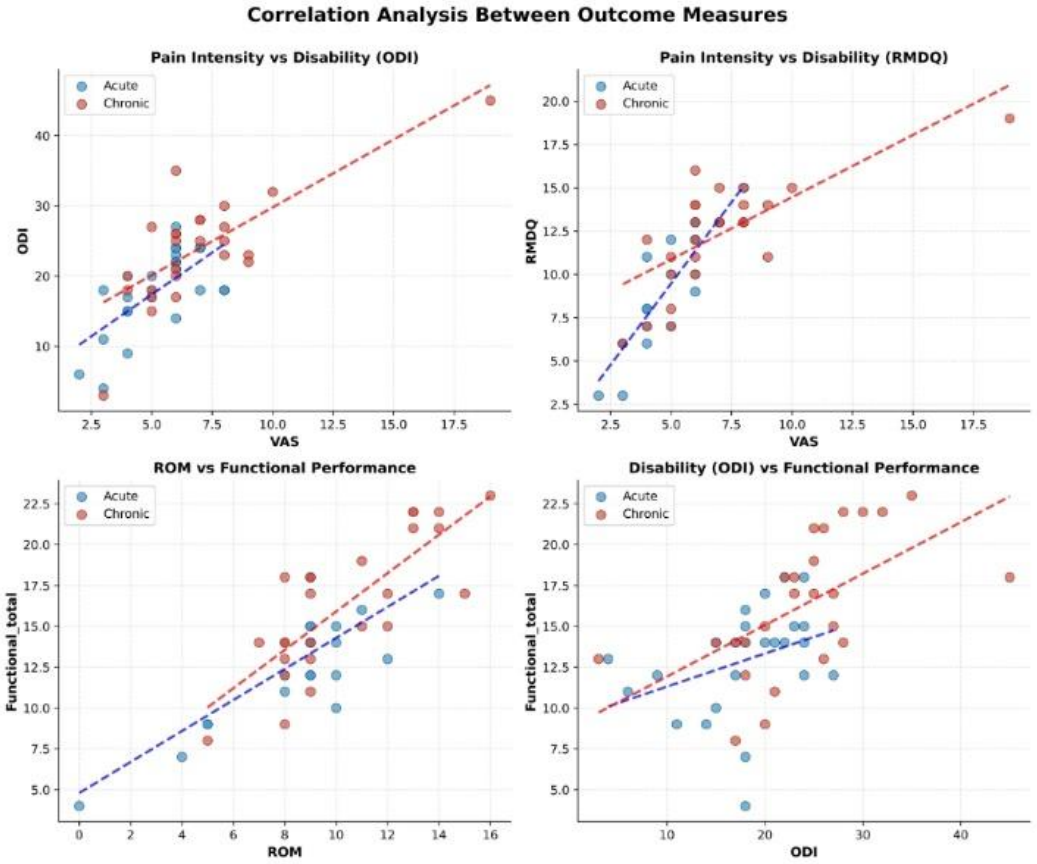

Figure 3 shows scatter plots illustrating the correlations between variables along with their corresponding regression lines.

Distribution Comparison of Key Clinical Measure

In Figure 4 the violin charts, one can see the distribution of densities for clinical measurements in both populations. In terms of Chronic LBP, the density distribution is wider and skewed, suggesting a high concentration of severe readings. On the other hand, Acute LBP has relatively narrow density distributions.

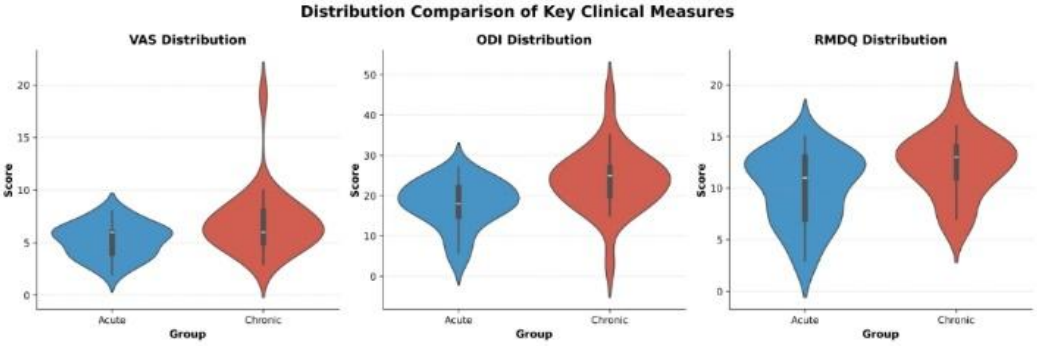

Figure 4 presents violin plots illustrating the distribution density of the clinical measures across the study groups.

Correlation Analysis by Groups

Figure 5 presents heat maps illustrating the relationships among the measured variables. The results show a strong positive correlation between pain, disability, and functional impairment. The color gradients effectively represent the strength of correlation between the variables.

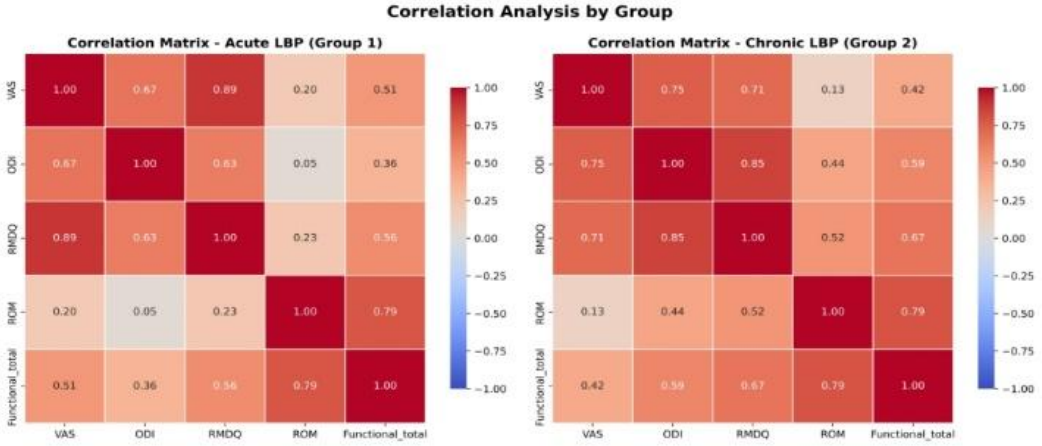

Figure 5 Correlation heat maps for acute and chronic LBP groups

DISCUSSION

This study yielded comparative data supporting the notion that chronic LBP patients exhibit significantly greater levels of pain, disability, and movement dysfunction than their acute LBP counterparts (25). These data support the existing literature on the progressive functional decline observed in LBP patients transitioning to chronic LBP (26). The data further expand this body of literature by situating this phenomenon within a conceptual framework of lower extremity alignment (27).

The idea of central sensitization and greater pain amplification is supported by the noticeably higher VAS values seen in patients with chronic LBP. Once LBP persists beyond the tissue healing period, peripheral noxious stimulation is increased by central nervous system changes, leading to allodynia, hyperalgesia, and this suggests increased pain perception even without new tissue damage. The variability in this patient group is further indicated by a higher standard deviation of VAS scores in patients with chronic low back pain.

The results from the ODI and RMDQ, therefore, collectively indicate that chronic LBP imposes significantly greater restrictions on activities of daily living, personal care, occupational functioning, and social participation. The mean ODI scores of the acute and chronic groups differed significantly, at 17.96% and 23.84%, respectively.

This is a significant difference directly relevant to patient management. With a mean age of 21, the degree of disability seen in young people is a major problem that calls for immediate therapeutic intervention.

The increase in lumbar ROM restriction observed in patients with chronic LBP is consistent with well-established neuromuscular adaptations, including muscle guarding, changes in the motor behavior of lumbar stabilizers such as multifidus and transversus abdominis, and fear avoidant behavior (28). The statistically significant difference observed in the composite functional movement score also indicates that patients with chronic LBP exhibit compensatory behavior that offloads the lumbar region at the expense of functional movement efficiency. Lower extremity malalignment, as measured clinically in the present study, is proposed to contribute to these deficits by continuing biomechanical disruption of the kinetic chain. The structural malalignment of the foot and knee will affect proximal movement and force transmission along the kinetic chain, possibly contributing to continued imbalances in lumbar muscle and joint loading. Although the direction of the relationship cannot be determined from the present data, the results are consistent with a cumulative effect model, in which malalignment is believed to contribute to the continued functional deterioration observed in patients with chronic disease.

This research used several outcome measures that were simultaneously valid, providing a holistic assessment of functional and disability status for each participant. The use of readily available, accessible data collection tools and outcome measures in a clinical setting will increase the

reproducibility of this research. The similar demographic profiles, especially age, will increase the validity of this research. The research question has been identified as a gap in current knowledge, which has direct implications for physiotherapy practice.

This study's primary drawback is its cross-sectional design, which makes it impossible to draw conclusions about the causal association between LE malalignment and LBP disability. The study's modest sample size, i.e., 25 per group, is another limitation. Convenience sampling was used for this study, which may have introduced biases. Visual assessment of LE alignment, though easy and practical, may have limited accuracy, as more reliable methods, such as X-ray and three dimensional analysis, are more accurate. Response biases can be seen in self-report measures such as the ODI and RMDQ, and this study included only young adults, limiting its generalizability to older LBP sufferers.

To ascertain the temporal link between malalignment and disability progression in individuals with lower extremity malalignment and LBP, future research must employ longitudinal methodologies. Additionally, more research is needed to measure malalignment using objective techniques including radiography, force plate analysis, and 3D analysis, as well as to include a larger variety of age groups. To ascertain the impact of orthotics, alignment-specific exercises, and physiotherapy on individuals with LBP and malalignment, intervention studies are also necessary. In addition, incorporating patient involvement along with the use of patient-reported outcome measures (PROMs) and patient-reported experience measures (PREMs) would be beneficial.

Conclusion

Compared to acute LBP patients, chronic LBP patients showed noticeably higher degrees of lumbar mobility dysfunction, functional impairment, and pain severity. The findings also indicate a higher lumbar range of motion restriction score in chronic LBP, reflecting greater movement limitation. Furthermore, the study highlights the clinical relevance of lower extremity malalignment as a contributing biomechanical factor associated with disability. These results support the inclusion of lower extremity alignment assessment in routine physiotherapy evaluations; however, to determine causal linkages and evaluate the efficacy of focused interventions in reducing chronicity, more study is necessary.

Highlights

1. Compared with individuals with acute low back pain, patients with chronic low back pain demonstrated higher levels of pain severity, disability, and reduced lumbar mobility.
2. Pes planus, genu varum/valgum, and limb length discrepancy are examples of lower extremity malalignments that seem to affect lumbar biomechanics and may be a factor in movement dysfunction.
3. The chronic group had significantly lower functional impairment scores (such as composite movement, forward bending, and sit-to-stand tests), which may indicate compensatory movement patterns and neuromuscular adaptation.
4. The results highlight how crucial it is to incorporate lower limb alignment evaluations into the assessment and treatment of lower back pain during physical therapy.
5. Longitudinal or interventional studies are advised to prove causal relationships between malalignment and chronicity, while cross-sectional data just reveals associations rather than proving causation.
6. The study offers clinical proof in favor of integrating neuromuscular and biomechanical processes to comprehend the development of impairment in LBP.

List of Abbreviations:

Low Back Pain (LBP), Range of Motion (ROM), Visual Analog Scale (VAS), Oswestry Disability Index (ODI), Roland–Morris Disability Questionnaire (RMDQ), Intraclass Correlation Coefficient (ICC), Global Burden of Disease (GBD), World Health Organization (WHO), Patient-Reported Outcome Measures (PROMs), Patient-Reported Experience Measures (PREMs), Standard Deviation (SD), Activities of Daily Living (ADLs), Lower Extremity (LE), Statistical Package for the Social Sciences (SPSS), Three-Dimensional (3D).

Acknowledgments
All data used in this study were derived from the project titled Influence of Lower Extremity Malalignments on Movement Kinematics and Disability in Acute vs. Chronic Low Back Pain Patients, conducted in Faisalabad, Pakistan.

Statements & Declarations

Author Contributions

Ahsan Saeed Chaudhary: Responsible for study conceptualization, development of methodology, software-related work, and preparation of the original manuscript draft.

Sahiba Noor: Involved in data collection (investigation) and organization of the dataset (data curation).

Muhammad Bilal: Contributed to investigation, data handling, and provision of study resources.

Ahmad Hassan: Participated in investigation, data management, and resource support.

Abiha Ahmad: Assisted with investigation, data curation, and resource provision.

Areeba Shabbir: Took part in the investigation, data organization, and provided the necessary resources.

Maha Irum: Participated in investigation, data management, and resource support

Sana: Assisted with investigation, data curation, and resource provision.

Laraib Zahid: Took part in the investigation, data organization, and provided the necessary resources.

Ameer Hamza: Involved in data collection (investigation) and organization of the dataset.

Ethical Consideration

Ethical approval was obtained from the Institutional Review Board of The Superior University, Lahore, Pakistan.

Consent to Participate

Informed consent was obtained from all participants included in the study.

Conflict of Interest

The authors declare that they have no conflict of interest.

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