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Association of Weight-Adjusted Waist Index and Waist-Hip Ratio with the severity of low back pain: A hospital based cross-sectional study

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Abstract

Background: Low back pain (LBP) is associated with obesity and central adiposity. This study evaluated associations of weight-adjusted waist index (WWI) and waist–hip ratio (WHR) with LBP severity and disability.

Methods: A hospital-based cross-sectional study was conducted from March to December 2025. A total of 500 patients aged 18–80 years with LBP were enrolled. Participants were categorized by pain duration: acute (<6 weeks, n=140), sub-acute (6-12 weeks, n=130), and chronic (>12 weeks, n=230). Anthropometric measurements (WWI, WHR, and BMI) were recorded. Pain intensity and functional disability were assessed using the visual analogue scale (VAS) and Nepali version of the Oswestry Disability Index (NV-ODI).

Results: WWI was significantly higher in chronic LBP patients (12.02 ± 1.18) than in acute and sub-acute groups (11.51 ± 1.07 and 11.51 ± 0.93; $p<0.001$). WHR showed a borderline association ($p\approx0.051$), while BMI was not significantly different across groups ($p>0.05$). VAS and NV-ODI scores were highest in chronic LBP (55.53 ± 11.47 and 46.82 ± 13.80; $p<0.001$). Overall, higher WWI was associated with greater pain severity and functional limitation, whereas BMI and WHR showed weaker associations.

Conclusion: WWI was associated with chronic LBP, greater pain, and disability, suggesting its potential value in assessing central adiposity in LBP management.

Keywords: Low back pain, weight-adjusted waist index, waist–hip ratio, body mass index

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Introduction

Low back pain is one of the most common musculoskeletal disorders. Approximately 80% of individuals experience LBP at least once in their lifetime creating a significant global health burden.[1] It is a major cause of disability, functional limitation, and reduced quality of life worldwide.[2] The Weight-Adjusted Waist Index (WWI) shows a significant association with chronic low back pain and obesity-related diseases.[3] Traditional obesity indices such as body mass index (BMI) have limitations and highlight the need for anthropometric measures that better integrates abdominal fat distribution.[4] The Weight-Adjusted Waist Index (WWI) is a novel anthropometric indicator that may better reflect central obesity and its associated health risks than traditional obesity measures.[5] Castro et al.[6] reported that visceral fat releases pro-inflammatory substances that contribute to intervertebral disc degeneration and low back pain. WWI represents both fat and muscle mass and may better assess abdominal obesity than body mass index (BMI) and waist circumference.[7] Kim JE et al.[8] found WWI to be strongly associated with sarcopenic obesity in older adults. The etiology of low back pain is multifactorial involving biological, behavioural, and psychosocial factors such as obesity, smoking, physical inactivity, heavy work, and poor posture.[9] Kim NH et al.[10] reported that WWI is positively associated with fat mass. Park Y et al.[11] demonstrated a positive linear relationship between WWI and cardio metabolic morbidity and mortality. WWI accounts for waist circumference by body weight and is independent of BMI.[11] Abdominal obesity increases spinal load and contributes to low back pain.[12] Anthropometric measures such as BMI, waist circumference, hip circumference, and waist-hip ratio (WHR) help in explaining body fat distribution and its role in low back pain.[13-15] However, WWI has been associated with chronic low back pain and obesity-related conditions but its relationship with different durations of low back pain particularly acute and sub-acute onset remains unclear. Comparing WWI with WHR may help determine whether these anthropometric measures are associated with severity across durations of low back pain. The study was conducted to assess the association of WWI and WHR with the severity of low back pain particularly in acute, sub-acute and chronic onset.

Methods

This hospital-based cross-sectional study was conducted from 1st April 2025 to 30th Jan 2026 patients aged 18 to 80 years presenting with LBP to the department of Orthopaedics and Spine Surgery were screened for eligibility. A consecutive sampling method was used, whereby all eligible patients presenting during the study period were included until the required sample size was reached. Pain intensity was assessed using the standard Visual Analog Scale (VAS), with patients rating their pain from 0 to 10 or (10 to 100), where 0 indicated no pain and 10 indicated the worst possible pain. Disability was assessed using the validated Nepali version of the Oswestry Disability Index (NV-ODI). Both questionnaires were completed by the patients during the clinical visit and the final scores were calculated according to the standard scoring methods.

Inclusion and Exclusion Criteria

Patients over 18 and below 80 years of age presented in orthopedics and Spine department from 1st April 2025 to 30th Jan 2026 with symptoms of low back pain who lived in eastern terai of Nepal and willing to participate in study with written consent were enrolled. Exclusion criteria included age <18 years and the presence of specific causes of LBP such as neoplastic disease, trauma, inflammatory systemic diseases, or infections (e.g., systemic lupus erythematous, rheumatoid arthritis, and spondylodiscitis). Patients with severe osteoporosis; cardio-cerebrovascular, hepatorenal, or gastrointestinal diseases; and pregnancy were also excluded. Additionally, patients receiving treatment with estrogen, vitamin D, nonsteroidal anti-inflammatory drugs (NSAIDs), or corticosteroids, or those unable to comply fully with the study protocol, were excluded.

All participants underwent clinical evaluation, X-rays, and blood tests. Sociodemographic and clinical data were collected. Pain and disability were assessed using VAS and NV-ODI scores.[2] Anthropometric measures included WWI, WHR, and BMI. All anthropometric measurements and clinical evaluations were performed by Dr. Pushkar Niraula of the same institute following a standardized procedure.

Anthropometric measurements

Weight, height, waist circumference, and hip circumference were measured following standard procedures.3 The measured values were recorded and used to calculate BMI, WWI, and WHR.

Weight Adjusted-Waist Index

The weight-adjusted waist index (WWI) is calculated as the waist circumference (WC) divided by the square root of body weight (kg).3 WWI interpreted as normal or low risk (<10.5 cm/√kg), borderline or moderate risk (10.5–11.0 cm/√kg) and high risk (>11.0 cm/√kg) indicating increasing central fat and cardiometabolic risk.

Waist-Hip Ratio

The waist–hip ratio (WHR) is the dimensionless ratio of the circumference of the waist to that of the hips. This is calculated as waist circumference (W) divided by hip circumference (H) (W/H).[15]

WHR categorized as excellent, good, average, and at risk: For males, <0.85, 0.85–0.89, 0.90–0.95, and >0.95, respectively. For females, <0.75, 0.75–0.79, 0.80–0.86, and >0.86, respectively.

Body Mass Index

Body Mass Index (BMI) is a measure of weight relative to height.[15]

The sample size was calculated using a standard formula. Using the prevalence of LBP reported by Que Z et al.[3] (23.3%), The margin of error was calculated as: $e = \sqrt{((z^2 \times p \times (1 - p)) / n)} = 0.037$, which corresponds margin of error of ± 3.7% at the 95% confidence level. The calculated sample size came to be 500. However, all eligible participants within the study period were included. Data were analyzed using appropriate statistical methods. Normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed variables were presented as mean ± standard deviation (SD) while non-normally distributed variables were presented as median (interquartile range, IQR). Categorical variables were presented as frequencies and percentages (n, %). For subgroup comparisons the independent-samples t-test or one-way ANOVA was used for normally distributed continuous variables while the Mann–Whitney U or Kruskal–Wallis test was used for non-normally distributed variables. Categorical variables were compared using the Chi-square test. Multivariable regression analysis was performed to adjust for potential confounders, including age, sex, BMI, and ethnicity. A p-value < 0.05 was considered statistically significant.

Results

A total of 500 patients patients with low back pain were include in this study which (122 males, 378 females; mean age 46.21 ± 14.43 years) were categorized as acute (<6 weeks), sub-acute (6–12 weeks), and chronic (>12 weeks) onset. Demographic and clinical variables were analysed across gender, ethnicity, and LBP onset groups. The mean values for key variables were: VAS (55.43 ± 13.15), ODI (44.60 ± 13.47), WWI (11.74 ± 1.12), WHR (0.99 ± 0.06), and BMI (25.65 ± 5.08).

Demographic Characteristics

The mean age of participants was 46.21 ± 14.43 years. Females constituted 75.6% (n = 378) and males 24.4% (n = 122). Regarding ethnicity, 62% (n = 310) were Hindu and 38% (n = 190) were Muslim. Based on symptom duration, 28% (n = 140) had acute LBP, 26% (n = 130) sub-acute LBP, and 46% (n = 230) chronic LBP.

Comparison by Ethnicity

Hindu and Muslim participants had similar age, VAS, and ODI scores (p>0.05). However, Muslims had significantly higher WWI (11.92 ± 1.29 vs. 11.64 ± 0.99), WHR (1.01 ± 0.05 vs. 0.98 ± 0.06), and BMI (27.29 ± 5.80 vs. 24.64 ± 4.29) than Hindus (all p<0.05). These differences are reported descriptively as ethnicity was not a primary clinical variable in this study.

Comparison by Gender

There were no statistically significant differences between females and males in VAS (p > 0.05) or ODI (p > 0.05). However, anthropometric measures differed significantly. Females had higher WWI and BMI, whereas males had slightly higher WHR (all p < 0.001) (Table 1, Figure 2).

Anthropometric Outcomes by LBP Onset

WWI differed significantly across LBP onset groups (p < 0.001), with the highest mean value observed in the chronic group (12.02 ± 1.18). In contrast, WHR showed a borderline association (p ≈ 0.051), and BMI did not differ significantly among groups (p > 0.05) (Table 2, Figure 3).

Clinical Outcomes by LBP Onset

VAS scores varied significantly across groups (p < 0.001), with the highest values in acute LBP, followed by chronic and sub-acute groups. ODI scores also differed significantly (p < 0.001), with the highest disability observed in chronic LBP patients (Table 2, Figures 4).

Table 1. Comparison of variables and Gender (n=500)

Variable	Female (Mean ± SD)	Male (Mean ± SD)	p-value
VAS (%)	55.65 ± 12.67	54.75 ± 14.56	0.5427
ODI (%)	44.70 ± 13.46	44.31 ± 13.58	0.7841
WWI	11.99 ± 1.08	10.97 ± 0.84	0.0000
WHR	0.99 ± 0.06	1.01 ± 0.06	0.0006
BMI	26.37 ± 4.96	23.41 ± 4.80	0.0000

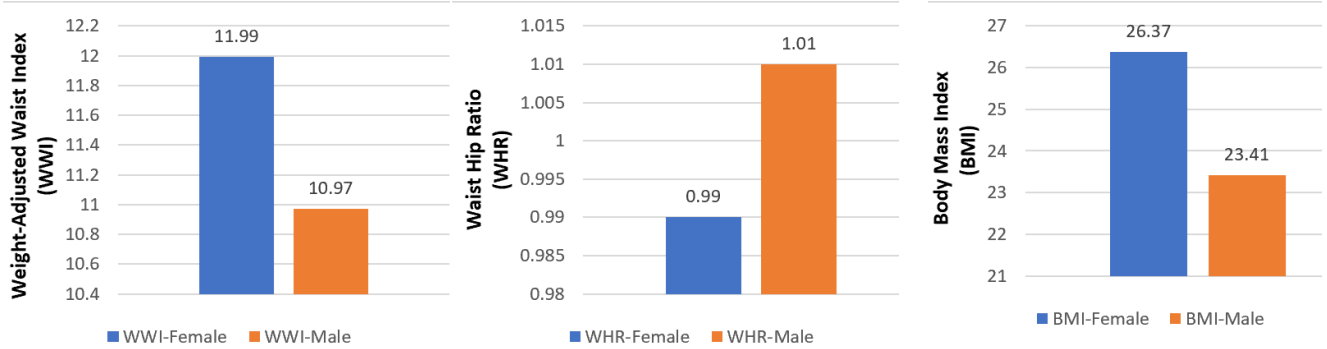


Figure 1 Comparison of variables among gender groups (n=500).

Table 2. Comparison of variables among three groups of Onset of LBP (n=500)

Variable	LBP Onset	n	Mean	SD	Min	Max	%	p-value
VAS (%)	Acute	140	58.31	13.97	20.00	80.00	28.0	0.00056
	Chronic	230	55.53	11.47	30.00	80.00	46.0	
	Sub-Acute	130	52.15	14.30	10.00	70.00	26.0	
	Overall	500	55.43	13.15	10.00	80.00	100.0	
ODI	Acute	140	45.29	13.46	12.00	72.00	28.0	0.00001
	Chronic	230	46.82	13.80	18.00	78.00	46.0	
	Sub-Acute	130	39.95	11.75	20.00	64.00	26.0	
	Overall	500	44.60	13.47	12.00	78.00	100.0	
WWI	Acute	140	11.51	1.07	7.62	13.59	28.0	0.000001
	Chronic	230	12.02	1.18	7.14	13.99	46.0	
	Sub-Acute	130	11.51	0.93	8.89	13.87	26.0	
	Overall	500	11.74	1.12	7.14	13.99	100.0	
WHR	Acute	140	0.997	0.058	0.87	1.20	28.0	0.051
	Chronic	230	0.992	0.055	0.80	1.13	46.0	
	Sub-Acute	130	0.980	0.073	0.82	1.13	26.0	
	Overall	500	0.990	0.061	0.80	1.20	100.0	
BMI	Acute	140	25.76	4.40	16.44	36.89	28.0	0.124
	Chronic	230	25.20	5.56	16.24	40.59	46.0	
	Sub-Acute	130	26.33	4.83	17.72	50.46	26.0	
	Overall	500	25.65	5.08	16.24	50.46	100.0	

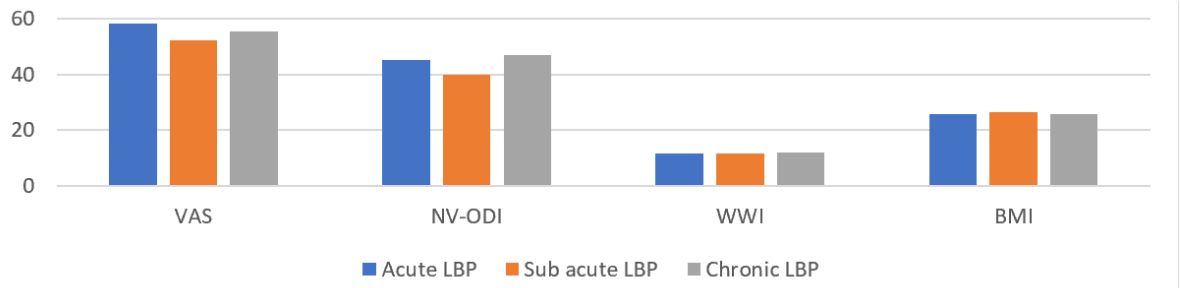


Figure 2 Comparison of variables among onset groups (n=500).

In multivariable regression analyses adjusting for age, gender, BMI, and ethnicity, WWI was significantly associated with both ODI (β = 2.67, p < 0.001) and VAS (β = 2.79, p < 0.001). WHR was significantly associated with ODI (β = 23.84, p = 0.046) but not with VAS. Age showed a significant positive association with both outcomes, whereas BMI, gender, and ethnicity were not statistically significant predictors. (Table 3).

Discussion

The present study examined the relationship between anthropometric indices and the severity and disability of low back pain. Our findings showed that WWI was higher among individuals with chronic low back pain compared with those with acute and subacute low back pain suggesting an association between greater central adiposity and chronicity of low back pain. This finding is consistent with the study by Que Z et

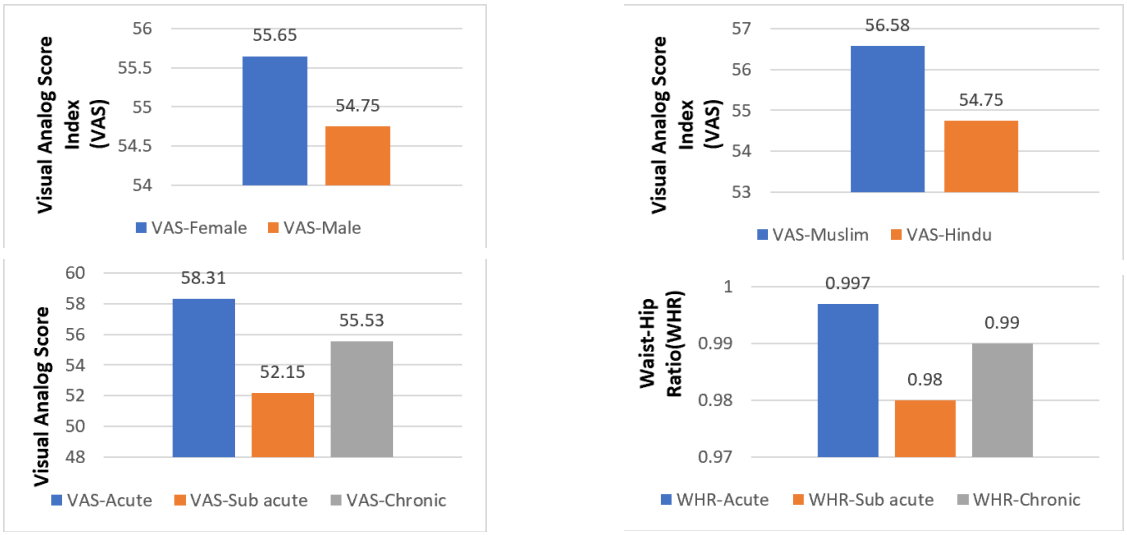


Figure 3 Comparison of VAS in Gender, Ethenicity, Onset groups (n=500).

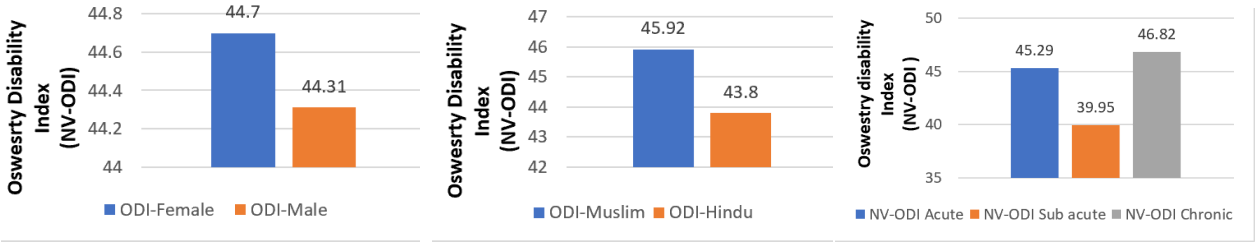


Figure 4 Comparison of NV-ODI in Gender, Ethenicity and Onset groups (n=500).

Table 3. Combined Multivariable Regression Table (VAS & ODI)

Variable	ODI (β ± SE)	p-value	95% CI	VAS (β ± SE)	p-value	95% CI
WWI	2.67 ± 0.73	<0.001	1.23 to 4.12	2.79 ± 0.78	<0.001	1.26 to 4.31
WHR	23.84 ± 11.93	0.046	0.40 to 47.28	0.48 ± 12.60	0.970	-24.28 to 25.23
Age	0.31 ± 0.04	<0.001	0.23 to 0.39	0.15 ± 0.04	0.001	0.06 to 0.24
BMI	-0.16 ± 0.13	0.216	-0.42 to 0.09	-0.10 ± 0.14	0.475	-0.37 to 0.17
Gender (Male vs. Female)	-0.84 ± 1.61	0.603	-4.01 to 2.33	0.71 ± 1.71	0.678	-2.64 to 4.06
Ethnicity (Muslim vs. Hindu)	0.99 ± 1.20	0.410	-1.37 to 3.35	1.46 ± 1.27	0.250	-1.03 to 3.95

al. which reported a positive association between WWI and severity of low back pain. The stronger association observed with WWI may be explained by its ability to better represent central adiposity than traditional measures such as BMI. Excess abdominal fat may increase mechanical loading on the lumbar spine and contribute to systemic inflammation which could influence the persistence of low back pain. In contrast, BMI reflects overall body mass and does not distinguish between fat and lean tissue or account for fat distribution. WHR provides some information about fat distribution but may be less sensitive to central adiposity than WWI. Pain intensity and disability showed different patterns across duration of low back pain. Acute LBP was associated with higher

pain intensity whereas chronic low back pain showed greater functional disability. This may reflect the multifactorial nature of chronic low back pain in which physical, behavioural, and psychosocial factors can contribute to persistent disability. Overall, these findings suggest that body fat distribution may be more relevant to low back pain than overall body weight alone. WWI may therefore be a useful anthropometric measure for identifying individuals with greater central adiposity who may be at risk of persistent or more disabling low back pain. The limitations of this study design prevents the establishment of causal relationships between anthropometric indices and low back pain outcomes and the study population was limited to specific geographic region. The confounding factors such as age, physical activity, occupational load, dietary habits, vitamin D status, bone mineral density, and sunlight exposure were not fully controlled. The measurement bias may have occurred due to variability in anthropometric assessments. However, further longitudinal studies are needed to determine whether higher WWI predicts the development or persistence of low back pain.

Conclusion

Chronic low back pain is associated with higher WWI, greater pain severity, and higher disability scores. WWI showed a stronger association with low back pain than WHR or BMI. Female patients had higher WWI and BMI indicating greater central obesity. Overall, WWI appears to be an indicator associated with low back pain for identifying prevalence, risk, severity, and disability compared to WHR or BMI.

Conflict of Interest: None
Acknowledgement: None
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