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# Correlation Coefficients of Hip Muscle Group Weakness and Imbalance with Low Back Pain

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## ABSTRACT

**Purpose:** Hip muscle weakness and asymmetry have been implicated in low back pain, but coexisting impairment does not establish an association with symptom severity. This study examined correlations between hip muscle grades and pain intensity, alongside exploratory bilateral and within-limb grade comparisons.

**Materials and Methods:** A cross-sectional study included 25 adults with low back pain attending private physiotherapy clinics in Zawia, Libya. Data collection began on 25 February 2019 and continued for three weeks. Bilateral hip and knee muscle actions were assessed using manual muscle testing on a 0–5 ordinal scale. Pain was labelled a visual analogue scale in the source, although its illustration depicts a 0–10 numeric rating scale. Available Pearson correlations and paired comparisons were reviewed; approximate confidence intervals for correlations were derived from reported coefficients and sample size.

**Results:** Participants comprised 15 men and 10 women. Hip muscle mean grades ranged from 2.20 to 3.32 on the right and 2.72 to 3.40 on the left. None of the 12 hip-grade correlations with pain reached the nominal 0.05 threshold (r = −0.365 to 0.081; P = 0.072–0.987). Hip flexion showed the largest negative correlations: right r = −0.362 (approximate 95% CI −0.662 to 0.039) and left r = −0.365 (−0.664 to 0.035). Hip extension grades were lower on the right than the left (mean difference −0.52 grades; reported P = 0.001). One bilateral internal-rotation output was internally inconsistent. No participant-level imbalance–pain coefficient was supplied.

**Conclusion:** Lower manual muscle grades and selected between-action or side-to-side differences coexisted with low back pain, but the study did not demonstrate a statistically significant association between individual hip grades and pain intensity. These small-sample findings neither establish muscle imbalance as a cause of pain nor exclude clinically relevant associations. (*Open J Biomed Res 2026;5:155-163*)

**Keywords:** Low back pain, hip muscles, manual muscle testing, muscle weakness, asymmetry, correlation.

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AUDIOABSTRACT

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## INTRODUCTION

Low back pain is a major clinical problem whose assessment requires attention to physical, psychological and social influences. Contemporary guidance for chronic primary low back pain supports individualized, person-centred care rather than attributing symptoms to a single impairment.[1] Assessment of hip function may contribute to a broader examination

because the lower limbs, pelvis and spine interact during movement.[2] The presence of a plausible biomechanical relationship, however, does not establish that a measured muscle deficit causes pain or explains differences in pain severity.

Observational studies have reported associations between hip muscle findings and low back pain, but their outcomes and populations differ. Cooper and colleagues found greater gluteus medius weakness in a chronic low back pain group than in matched controls.[3] Nourbakhsh and Arab investigated several mechanical characteristics in participants with and without low back pain, identifying selected strength and endurance associations.[4] Such comparisons address the presence of low back pain. They are distinct from testing whether strength varies with pain intensity among people who all already have symptoms.

Muscle weakness, asymmetry and functional instability should also be distinguished. Weakness refers to reduced performance relative to an appropriate reference; bilateral asymmetry describes differences between sides. Neither is equivalent to a validated measure of pelvic control. Kendall and colleagues found that hip-abductor strength was poorly correlated with pelvic drop in their small clinical study.[5] Nadler and colleagues examined hip strength differences and subsequent low back pain in collegiate athletes, but the findings cannot automatically be generalized to a mixed-age outpatient population.[6]

Manual muscle testing is accessible in routine practice, yet its ordinal grades are not direct measurements of force or torque. Examiner resistance and limited discrimination can affect interpretation.[7] Standardized dynamometry provides an alternative approach to quantitative hip-strength measurement when suitable equipment and examiner procedures are available.[8] These measurement distinctions are particularly important when interpreting correlations and comparisons between different muscle actions.

The present study aimed to describe hip muscle grades and their correlations with pain intensity in adults attending physiotherapy clinics in Zawia, Libya. Secondary aims were to summarize bilateral and within-limb grade differences and report knee-muscle findings. Because the available outputs did not include correlations between an individual asymmetry or antagonist-imbalance measure and pain, those associations could not be directly evaluated.

## MATERIALS AND METHODS

### *Study Design and Participants*

A cross-sectional observational study was conducted in the physiotherapy services of Nesma, Alsanapel and Future clinics in Zawia, Libya. Data collection commenced on 25 February 2019 and continued for three weeks. The study included 25 adults attending these services with low back pain. All participants underwent pain-intensity assessment and bilateral testing of hip and knee muscle performance.

The study population comprised symptomatic patients without an asymptomatic comparison group. Symptom duration and diagnostic subclassification were not established; the population was therefore described as adults with low back pain rather than as a chronic or nonspecific low back pain cohort. Participants were informed about the study purpose and procedures, participation was voluntary, and withdrawal was permitted. Identifying information was handled confidentially.

### *Clinical Measurements*

Participants completed a study-specific questionnaire and underwent bilateral manual muscle testing of hip flexion, extension, abduction, adduction, internal rotation and external rotation, together with knee flexion and extension. Muscle performance was graded on

an ordinal scale from 0 to 5, with higher grades indicating better performance. Grade 0 denoted no contraction, grade 1 a trace contraction, grade 2 movement with gravity eliminated, grade 3 movement against gravity, grade 4 movement against resistance and grade 5 normal power through the full range of movement.

Hip abduction and adduction were assessed in side-lying, hip flexion and rotation in sitting, and hip extension in prone. Knee flexion was assessed in prone and knee extension in sitting. Resistance was applied manually to the tested limb. Measurements represented clinical performance grades rather than instrumented force or torque. Dynamometry, electromyography and muscle-endurance testing were not performed.

Pain intensity was assessed by self-report. Instrument identification requires confirmation because the assessment documentation uses the term visual analogue scale, whereas the accompanying illustration depicts a 0–10 numeric rating scale anchored by no pain and worst possible pain. The outcome is referred to as pain intensity throughout the manuscript to avoid assigning an unverified instrument or scoring protocol.

The questionnaire also recorded age, sex and categorical information on daily sitting and driving time. Sitting and driving were included as exploratory variables. Disability, fear avoidance and other psychosocial outcomes were not assessed using validated measures.

### *Statistical Analysis*

The primary analysis examined associations between pain intensity and the 12 bilateral hip muscle grades. Knee-muscle associations and comparisons between sides or muscle actions were secondary exploratory analyses. Muscle grades were summarized as means and standard deviations to maintain comparability with the available aggregate results. These summaries describe ordinal scores and were not interpreted as quantitative force, torque or percentages of normal strength.

Associations between muscle grades and pain intensity were summarized using Pearson correlation coefficients (r). Approximate 95% confidence intervals were calculated using Fisher's transformation, $z = \operatorname{arctanh}(r)$, with standard error $1/\sqrt{(n-3)}$, followed by back-transformation of $z \pm 1.96$ standard errors. Each estimate was based on 25 participants. Confidence intervals were derived from rounded coefficients and were conditional on the assumptions of the Pearson method. A negative coefficient indicated that higher pain intensity was associated with a lower muscle grade.

Paired-sample t tests were used to examine bilateral and within-limb grade contrasts. Spearman coefficients summarized associations of pain intensity with sitting and driving categories. All tests were two-sided, and $P < 0.05$ was used as the nominal significance threshold. P values were unadjusted for multiple comparisons, and values rounded to 0.000 were expressed as $P < 0.001$. Between-action grade differences were interpreted as scored contrasts rather than physiological antagonist ratios.

Analyses were based on aggregate statistics and correlation matrices; participant-level reanalysis was not performed. Rank-based sensitivity analyses, confounder adjustment and correlations between individual imbalance measures and pain intensity were consequently unavailable. The bilateral internal-rotation test was excluded from inferential interpretation because its test statistic conflicted with equal right and left means. The hip-flexion P value of 0.050 was retained as a rounded boundary value.

## RESULTS

### *Participant Characteristics*

Twenty-five adults participated in the study, including 15 men (60%) and 10 women (40%). The largest age category was 32–43 years (n = 8; 32%), followed by 20–31 years (n = 7; 28%). Five participants (20%) were aged

44–55 years and five (20%) were in the 56–67-year category (Table 1).

**Table 1:** Participant characteristics.

| Characteristic | Category | n | % |
|---|---|---|---|
| Sex | Male | 15 | 60 |
| Sex | Female | 10 | 40 |
| Age in years | 20–31 | 7 | 28 |
| Age in years | 32–43 | 8 | 32 |
| Age in years | 44–55 | 5 | 20 |
| Age in years | 56–67 | 5 | 20 |

### *Muscle grades and bilateral comparisons*

Mean hip muscle grades ranged from 2.20 to 3.32 on the right and from 2.72 to 3.40 on the left (Table 2). Hip extension had the lowest mean grade bilaterally: 2.20 (SD 0.87) on the right and 2.72 (SD 1.06) on the left. Mean hip-flexion grades were 3.12 (SD 0.73) and 3.40 (SD 0.50), respectively. Knee-extension grades averaged 3.52 on both sides. The largest mean bilateral difference occurred in hip extension, with a lower grade on the right than on the left (mean difference −0.52 grades; t = −3.641; P = 0.001). Hip flexion was lower on the right by 0.28 grades (t = −2.064; P = 0.050). The remaining interpretable bilateral comparisons did not reach the nominal significance threshold (all P ≥ 0.161).

**Table 2:** Manual muscle grades and exploratory bilateral comparisons.

| Muscle action | Right mean (SD) | Left mean (SD) | Right minus left | P value |
|---|---|---|---|---|
| Hip flexion | 3.12 (0.73) | 3.40 (0.50) | −0.28 | 0.050 |
| Hip extension | 2.20 (0.87) | 2.72 (1.06) | −0.52 | 0.001 |
| Hip adduction | 3.32 (0.95) | 3.28 (0.98) | 0.04 | 0.832 |
| Hip abduction | 3.16 (0.85) | 3.20 (0.41) | −0.04 | 0.802 |
| Hip external rotation | 3.32 (0.75) | 2.96 (0.79) | 0.36 | 0.161 |
| Hip internal rotation | 3.12 (0.73) | 3.12 (0.93) | 0.00 | Unresolved |
| Knee extension | 3.52 (0.71) | 3.52 (0.87) | 0.00 | 1.000 |
| Knee flexion | 3.16 (0.75) | 3.20 (0.91) | −0.04 | 0.814 |

n = 25 for each action. Values are mean (SD) ordinal grades. Differences are right minus left. P values are from exploratory paired t tests without multiplicity adjustment. The internal-rotation test is withheld because its statistic conflicts with equal bilateral means. The flexion P value of 0.050 is rounded.

### *Correlations of muscle grades with pain intensity*

None of the 12 hip muscle-grade correlations with pain intensity reached statistical significance (r = −0.365 to 0.081; all P ≥ 0.072; Table 3). Hip flexion showed the largest negative coefficients on both sides: right r =

−0.362 (approximate 95% CI −0.662 to 0.039; P = 0.076) and left r = −0.365 (approximate 95% CI −0.664 to 0.035; P = 0.072). All hip correlation intervals included zero.

Knee muscle grades were also not significantly correlated with pain intensity. Coefficients ranged from −0.225 for left knee extension to 0.127 for left knee flexion (P = 0.280–0.544). No correlation coefficient was available for the association between pain intensity and an individual bilateral difference or other imbalance index.

**Table 3:** Correlations between muscle grades and pain intensity.

| Muscle action | Side | Pearson r | Approximate 95% CI | P value |
|---|---|---|---|---|
| Hip flexion | Right | −0.362 | −0.662 to 0.039 | 0.076 |
| Hip extension | Right | −0.201 | −0.552 to 0.211 | 0.334 |
| Hip adduction | Right | 0.021 | −0.377 to 0.413 | 0.920 |
| Hip abduction | Right | −0.086 | −0.465 to 0.320 | 0.683 |
| Hip internal rotation | Right | −0.084 | −0.464 to 0.322 | 0.689 |
| Hip external rotation | Right | −0.190 | −0.544 to 0.222 | 0.363 |
| Hip flexion | Left | −0.365 | −0.664 to 0.035 | 0.072 |
| Hip extension | Left | −0.114 | −0.487 to 0.294 | 0.587 |
| Hip adduction | Left | −0.003 | −0.398 to 0.393 | 0.987 |
| Hip abduction | Left | 0.081 | −0.325 to 0.461 | 0.699 |
| Hip internal rotation | Left | −0.193 | −0.546 to 0.219 | 0.354 |
| Hip external rotation | Left | −0.029 | −0.419 to 0.370 | 0.889 |
| Knee extension | Right | −0.158 | −0.521 to 0.253 | 0.450 |
| Knee flexion | Right | −0.209 | −0.558 to 0.203 | 0.315 |
| Knee extension | Left | −0.225 | −0.569 to 0.187 | 0.280 |
| Knee flexion | Left | 0.127 | −0.282 to 0.497 | 0.544 |

All n = 25. Pearson coefficients and two-sided P values are presented with approximate, unadjusted 95% confidence intervals calculated by Fisher's transformation from rounded r values. Higher muscle grades indicate better performance. Knee-muscle analyses are secondary.

### *Exploratory comparisons between muscle actions*

Hip-flexion grades exceeded hip-extension grades on both sides, with mean differences of 0.92 grades on the right (P < 0.001) and 0.68 grades on the left (P = 0.007; Table 4). Knee-extension grades exceeded knee-flexion grades by 0.36 on the right (P = 0.009) and 0.32 on the left (P = 0.043). Adduction–abduction and internal–external rotation contrasts did not reach the nominal significance threshold on either side (all P ≥ 0.134).

**Table 4:** Exploratory within limb grade contrasts.

| Contrast | Side | Mean grade difference | P value |
|---|---|---|---|
| Hip flexion minus extension | Right | 0.92 | <0.001 |
| Hip adduction minus abduction | Right | 0.16 | 0.491 |
| Hip internal minus external rotation | Right | −0.20 | 0.134 |
| Knee extension minus flexion | Right | 0.36 | 0.009 |
| Hip flexion minus extension | Left | 0.68 | 0.007 |
| Hip adduction minus abduction | Left | 0.08 | 0.692 |
| Hip external minus internal rotation | Left | −0.16 | 0.327 |
| Knee extension minus flexion | Left | 0.32 | 0.043 |

n = 25. Mean differences and two-sided paired t-test P values describe exploratory contrasts between ordinal grades. P values are unadjusted for multiple comparisons. These differences are not force or torque ratios.

### *Exploratory demographic and activity associations*

Pain intensity was not significantly associated with age (r = 0.318; P = 0.121). An association was observed with the numerical sex code (r = 0.465; P = 0.019), although its direction could not be attributed to either sex because the code mapping was unavailable. Associations with sitting category (Spearman ρ = −0.390; P = 0.054) and driving category (ρ = −0.380; P = 0.061) did not reach the nominal significance threshold.

## DISCUSSION

This exploratory study found low mean manual muscle grades and selected paired differences in adults seeking physiotherapy for low back pain. Its main association result was that no individual hip or knee grade showed a statistically significant correlation with pain intensity. The original suggestion that weakness or imbalance explained increasing pain is therefore not supported by the reported pain-correlation results. At the same time, the small sample and wide intervals do not exclude associations of clinical interest. These two points should be maintained together when interpreting the findings.

The distinction between impairment and symptom association is central. A mean below grade 5 indicates that the sample did not, on average, receive the maximum score; it does not measure excess weakness relative to an appropriate control population. A mean difference between sides describes asymmetry in tested grades. Neither observation estimates whether participants with greater asymmetry experience greater pain. The latter question requires a participant-level asymmetry measure linked to the pain score, which was not supplied.

The current correlations do not directly contradict the group differences reported by Cooper and colleagues.[3] That study compared people with chronic low back pain with controls; the present sample comprised only symptomatic participants. Restricted variation in a clinical sample can limit the ability to identify a within-group association. Nourbakhsh and Arab likewise compared mechanical characteristics across people with and without pain, examining occurrence rather than only symptom intensity.[4] Their report did not support the source project's blanket assumption that hamstring or iliopsoas length explains low back pain.

Hip-extension grades were particularly low in the present sample, but the measurement does not identify the underlying mechanism.

Kankaanpää and colleagues investigated extensor fatigability using an endurance task and electromyographic analysis.[9] Fatigability is not equivalent to a single manual strength grade. Similarly, research by Leung and colleagues addressed piriformis muscle size, injury and motor-control training in elite football players.[10] That evidence concerns a specific muscle and athletic setting and cannot establish the origin of low manual grades in this outpatient sample.

The bilateral extension finding is compatible with the possibility of asymmetric hip performance, but its clinical meaning remains undetermined. Nadler's athlete study used a different strength-assessment and follow-up framework, with population-specific results.[6] Kendall's observation that hip-abductor strength was poorly related to pelvic drop further cautions against inferring pelvic instability directly from strength scores.[5] The present study did not measure pelvic kinematics, segmental instability or muscle activation, so these mechanisms remain explanations to be tested rather than observed results.

Manual muscle testing offers a practical clinical description of performance but produces ordered categories with unequal physiological intervals. A change from grade 2 to grade 3 is not equivalent to a fixed force increment, and the same numerical grade in flexion and extension does not imply equal available torque. Measurement literature identifies limits in discrimination and dependence on testing procedures.[7] This constrains Pearson correlation, t tests and interpretation of mean grade ratios. A negative correlation here links higher pain to a lower numerical grade; it is not a coefficient for a separately defined weakness construct.

The testing description also merits reconciliation with the observed grades. Several mean extension grades were below the level associated with full antigravity movement, yet the report describes primarily antigravity or resisted positions. The original forms should establish whether gravity-eliminated testing was performed and whether pain inhibition, incomplete range or scoring conventions affected grades. Standardized dynamometry may improve future quantification of hip strength, but equipment alone would not resolve diagnostic uncertainty, confounding or sampling bias.[8]

The approximate correlation intervals add information about uncertainty without replacing the missing participant-level analysis. All hip intervals include zero; several also allow moderate negative associations. The reported nonsignificant P values therefore should not be rewritten as "no relationship" or as proof that a hypothesis is false. Conversely, isolated nominal paired or sex-code findings require caution because many analyses were performed without a documented multiplicity strategy. The contradictory bilateral internal-rotation output further limits confidence in the source tables until checked against the original dataset.

The data support documenting hip performance as part of a comprehensive examination, but they do not establish that correcting a particular grade difference will reduce pain. Jeong and colleagues studied a combined gluteal-strengthening and lumbar-stabilization intervention, a treatment design distinct from the present cross-sectional analysis.[11] A later meta-analysis judged evidence for short-term benefits of hip-targeted interventions to be of very low certainty.[12] These findings may inform further research but do not convert the current observations into treatment-effect evidence.

Ruas and Vieira's review also cautioned against assuming a direct relationship between hip-strength imbalance and low back pain or that normalizing imbalance necessarily improves symptoms.[13] Clinical exercise decisions should be individualized and considered alongside the broader care approach described in relevant guidelines.[14]

The present study provides no basis for prescribing a universal corrective program, diagnosing instability from manual grades or attributing an individual patient's symptoms to weakness alone.

The study is limited by its small clinic-based sample, incompletely specified recruitment, absence of controls and unavailable participant-level data. Diagnostic categories, pain duration, age details, body mass index, physical activity, comorbidities and treatment exposure were insufficiently described. Baseline pain distribution, disability and potential psychosocial influences were not reported. The pain-instrument discrepancy and uncertain manual-testing reliability constrain measurement interpretation, and no objective force or torque values were collected.

Cross-sectional observations cannot establish whether reduced performance preceded pain, followed pain or reflected another factor. The ordinal scale, numerous unadjusted analyses and internal inconsistency in one paired output further limit inference. No individualized imbalance–pain analysis was available, and grade means cannot establish prevalence. Completion of the relevant STROBE reporting items is needed, while recognizing that reporting improvements cannot recover missing measurements.[15]

A follow-up study should define the low back pain population and prespecify whether it investigates symptom presence, intensity, disability or prognosis. It should use a clearly identified pain instrument, standardized bilateral strength testing with reliability estimates, and an a priori definition of asymmetry. Sample size should be justified for the primary association, and an analysis appropriate to the measurement scale should report uncertainty and address confounding. Prospective observation would be needed to study temporal ordering; an intervention trial would be required to evaluate a treatment claim.

## CONCLUSION

Among 25 adults with low back pain, mean hip manual muscle grades were below the scale maximum and selected between-side and between-action differences were reported. None of the individual hip-grade correlations with pain intensity reached the nominal significance threshold, and an individual imbalance–pain correlation was not estimated. The findings do not establish hip muscle weakness or imbalance as a cause of increasing low back pain.

## AUTHOR CONTRIBUTIONS

**Mostafa M. Elsoltan:** Conceptualization, methodology, writing – original draft, investigation, data curation, and manuscript preparation, validation, critical review, writing – review & editing, and final approval of the manuscript. **Hasan M. Alseeleeni:** Conceptualization, methodology, writing – original draft, investigation, data curation, and manuscript preparation, validation, critical review, writing – review & editing, and final approval of the manuscript. **Aisha H. Ehmeed:** Writing – original draft, investigation, data curation, manuscript preparation, and final approval of the manuscript. **Esraa E. Mahamed:** Writing – original draft, investigation, data curation, manuscript preparation, and final approval of the manuscript.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest concerning the research, authorship, and publication of this article.

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