

HIGH-RESOLUTION ULTRASOUND ASSESSMENT OF SCIATIC NERVE CROSS-SECTIONAL AREA IN WORKERS WITH SCIATICA: AN ANALYTICAL CASE-CONTROL STUDY OF MODIFIABLE ERGONOMIC EXPOSURES

Dr Sri Indira Kumar Udayakumar^{1*}, Dr Karthik Krishna Ramakrishnan², Dr Paarthipan Natarajan³,
Dr Jeeva Harini Saravanan⁴

¹Department of Radiology, Saveetha Medical College and Hospital, SIMATS, Chennai, India

²Department of Radiology, Saveetha Medical College and Hospital, SIMATS, Chennai, India

³Department of Radiology, Saveetha Medical College and Hospital, SIMATS, Chennai, India

⁴Department of Radiology, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India.

*Corresponding author: Dr Sri Indira Kumar Udayakumar, sriindirakumar@gmail.com

ABSTRACT

Background: Workplace exposures such as prolonged sitting, sustained forward flexion, repetitive lifting, whole-body vibration, and poor workstation design may accompany sciatic symptoms. Objective structural markers of peripheral sciatic nerve involvement remain limited.

Objective: To compare sciatic nerve cross-sectional area (CSA) and side-to-side asymmetry between workers with unilateral sciatica and asymptomatic controls and to examine their associations with modifiable ergonomic exposures.

Methods: This hospital-based analytical case-control study included 80 adults aged 20–60 years: 40 cases with clinically diagnosed unilateral sciatica and 40 asymptomatic controls selected from comparable age and occupational groups. Bilateral sciatic nerves were examined by high-resolution ultrasonography at the gluteal and mid-thigh levels. Daily sitting duration, forward-flexion score, repetitive lifting frequency, workstation ergonomics, and occupational exposure duration were assessed. Group comparisons, Pearson correlation, multivariable logistic regression, and receiver operating characteristic analysis were performed.

Results: Gluteal CSA was greater in cases on the symptomatic side than in controls (25.4 ± 4.8 vs 14.2 ± 2.9 mm²; $p < 0.001$), as was mid-thigh CSA (22.1 ± 4.2 vs 12.8 ± 2.6 mm²; $p < 0.001$). Side-to-side asymmetry was also higher in cases ($38.2 \pm 12.4\%$ vs $8.6 \pm 5.1\%$; $p < 0.001$). Ergonomic exposures correlated positively with CSA ($r = 0.53$ – 0.69 ; all $p < 0.001$). A gluteal CSA cutoff of ≥ 18.5 mm² yielded an area under the curve of 0.94, with 90.0% sensitivity and 87.5% specificity in this sample.

Conclusion: Workers with unilateral sciatica showed greater sciatic nerve CSA and asymmetry than asymptomatic controls, and these findings were associated with ergonomic burden. High-resolution ultrasonography may provide an adjunctive structural assessment, but the observed thresholds require external validation and the case-control design does not establish causality.

Keywords: Case-control study, Ergonomic exposure, High-resolution ultrasound, Occupational sciatica, Sciatic nerve, Cross-sectional area

How to cite this article: Udayakumar SIK, Ramakrishnan KK, Natarajan P, Saravanan JH., High-Resolution Ultrasound Assessment of Sciatic Nerve Cross-Sectional Area in Workers with Sciatica: An Analytical Case-Control Study of Modifiable Ergonomic Exposures. Int J Drug Deliv Technol. 2026;16(7): 1504-1508; DOI: 10.25258/ijddt.16.7.162

Source of support: No external funding was received.

Conflict of interest: The authors declared no conflict of interest.

INTRODUCTION

Low back pain remains a leading contributor to disability worldwide, and its global burden is projected to increase.¹ Sciatica represents radiating leg pain arising from heterogeneous mechanisms, including lumbar radiculopathy, peripheral sciatic nerve irritation, and deep-gluteal causes.^{2–4} Clinical guidance therefore emphasizes red-flag assessment, neurological examination, functional evaluation, and staged conservative management before advanced intervention in uncomplicated presentations.^{5–7}

Occupational mechanical exposures provide potentially modifiable contributors to low-back and lower-limb symptoms. Lifting, bending, kneeling, and whole-body vibration have been associated with chronic low-back pain and severe sciatica, while

psychosocial and work-organization factors may influence persistence and disability.^{8–10} Sitting duration alone is unlikely to explain symptoms without considering posture, break patterns, task demands, and workstation design.^{11–12} Workplace programs that combine ergonomic correction, activity breaks, education, and exercise may reduce pain and disability, although intervention content and certainty of evidence vary.^{13–15}

High-resolution ultrasonography (HRUSG) permits real-time assessment of peripheral nerve calibre, continuity, fascicular architecture, and focal swelling.^{16–18} Imaging studies support its use as an adjunct to clinical assessment and magnetic resonance neurography in peripheral nerve disorders.¹⁹ Interpretation requires standardized measurement sites because nerve CSA varies with anatomical level, body habitus, and population.^{20–23}

Bilateral measurement can be especially informative in unilateral symptoms when acquisition technique is consistent.²⁴

Evidence directly linking workplace ergonomic burden to sciatic nerve morphology remains limited. This study therefore compared gluteal and mid-thigh sciatic nerve CSA, echotexture, and side-to-side asymmetry in workers with unilateral sciatica and asymptomatic controls. It also examined associations between ultrasound findings and sitting duration, forward flexion, repetitive lifting, workstation ergonomics, and years of occupational exposure, and explored study-specific CSA thresholds for discriminating case status.

MATERIALS AND METHODS

Study design, setting, and ethics

A hospital-based analytical case-control study was conducted in the Department of Radiology, Saveetha Medical College and Hospital, SIMATS Deemed University, Chennai, India. The study included 80 participants: 40 cases with unilateral sciatica and 40 asymptomatic controls. Ethical approval was obtained from the Saveetha Research Board, and written informed consent was obtained from all participants.

Participants

Ergonomic exposure assessment

A structured assessment recorded daily sitting duration (hours/day), forward-flexion posture score on a 0–5 ordinal scale, repetitive lifting frequency as the number of lifts of at least 5 kg per day, workstation ergonomics, and years of occupational exposure. The workstation score incorporated chair and lumbar support, screen height, keyboard position, and rest-break frequency; higher scores represented poorer ergonomics.

Outcome measures

Ultrasound outcomes were symptomatic-side gluteal and mid-thigh CSA, contralateral gluteal CSA, side-to-side asymmetry, and abnormal echotexture. Exposure outcomes were sitting duration, forward-flexion score, repetitive lifting frequency, workstation ergonomics score, and years of occupational exposure. Exploratory diagnostic performance was assessed from ROC-derived CSA cutoffs.

Statistical analysis

Participants were 20–60 years of age and had worked in the index occupation for at least one year. Cases had clinically diagnosed unilateral sciatica that developed or was aggravated in temporal association with occupational exposure, including desk-based work, driving, or manual labour. Controls were selected from comparable age and occupational groups and had no history of low-back pain, lower-limb pain, or neurological symptoms. Participants with MRI-confirmed structural lumbar disc prolapse with radiculopathy, clinically confirmed piriformis syndrome, previous lumbar-spine surgery, inflammatory neuropathy, or diabetes mellitus were excluded.

Ultrasound assessment

Both sciatic nerves were examined with a 7–12 MHz linear transducer. A 4–8 MHz curvilinear transducer was used when greater penetration was required in participants with higher body mass index. Participants were positioned prone. The nerve was localized at the gluteal level and at the mid-thigh level in transverse section, and CSA was measured by direct tracing along the inner margin of the hyperechoic epineurial rim. Echogenicity and preservation of the normal fascicular pattern were also recorded.

The side-to-side asymmetry index was calculated as:

$$\frac{\text{symptomatic} - \text{sideCSA} - \text{contralateralCSA}}{\text{contralateralCSA}} \times 100\%$$

Continuous variables were summarized as mean $\pm$ standard deviation, and categorical variables as counts and proportions. Independent-samples *t* tests compared continuous variables between cases and controls; categorical distributions were compared using an appropriate contingency-table test. Pearson correlation assessed relationships between ergonomic exposures and sciatic nerve CSA. Multivariable logistic regression estimated exposure associations with case status after adjustment for age, sex, and body mass index. Receiver operating characteristic analysis evaluated the discriminative performance of gluteal and mid-thigh CSA. Statistical significance was defined as a two-sided *p* value < 0.05 .

RESULTS

Participant characteristics and ergonomic exposures

The groups were similar in age, sex distribution, and body mass index. Cases reported longer daily sitting, greater forward-flexion exposure, and more frequent repetitive lifting than controls (Table 1).

Table 1. Baseline characteristics and ergonomic exposure

Variable	Cases (n = 40)	Controls (n = 40)	p value
Age (years)	38.7 $\pm$ 9.4	37.9 $\pm$ 8.8	0.68
Male:female	24:16	22:18	0.71
BMI (kg/m ²)	27.3 $\pm$ 3.8	26.8 $\pm$ 3.5	0.52
Sitting duration (hours/day)	7.8 $\pm$ 1.6	4.1 $\pm$ 1.3	<0.001
Forward-flexion exposure score	3.4 $\pm$ 0.9	1.2 $\pm$ 0.6	<0.001
Repetitive lifting frequency (lifts/day)	18.6 $\pm$ 8.4	6.3 $\pm$ 4.7	<0.001

Values are mean $\pm$ standard deviation unless otherwise stated. BMI, body mass index.

Sciatic nerve CSA, asymmetry, and echotexture

Symptomatic-side sciatic nerve CSA was greater in cases at both measurement levels. Cases also had greater contralateral gluteal CSA and markedly greater side-to-side asymmetry than controls

(Table 2). Hypoechoic swelling with loss of the normal fascicular pattern was reported in approximately 78% of symptomatic nerves.

Table 2. Sciatic nerve cross-sectional area and side-to-side asymmetry

Parameter	Cases	Controls	p value	Effect size (d)
Gluteal CSA (mm ²)	25.4 $\pm$ 4.8	14.2 $\pm$ 2.9	<0.001	2.71
Mid-thigh CSA (mm ²)	22.1 $\pm$ 4.2	12.8 $\pm$ 2.6	<0.001	2.59
Contralateral gluteal CSA (mm ²)	16.3 $\pm$ 3.1	14.0 $\pm$ 2.8	0.002	0.78
Side-to-side asymmetry (%)	38.2 $\pm$ 12.4	8.6 $\pm$ 5.1	<0.001	3.12

For cases, gluteal and mid-thigh values refer to the symptomatic side. CSA, cross-sectional area; d, standardized mean difference as reported in the source analysis.

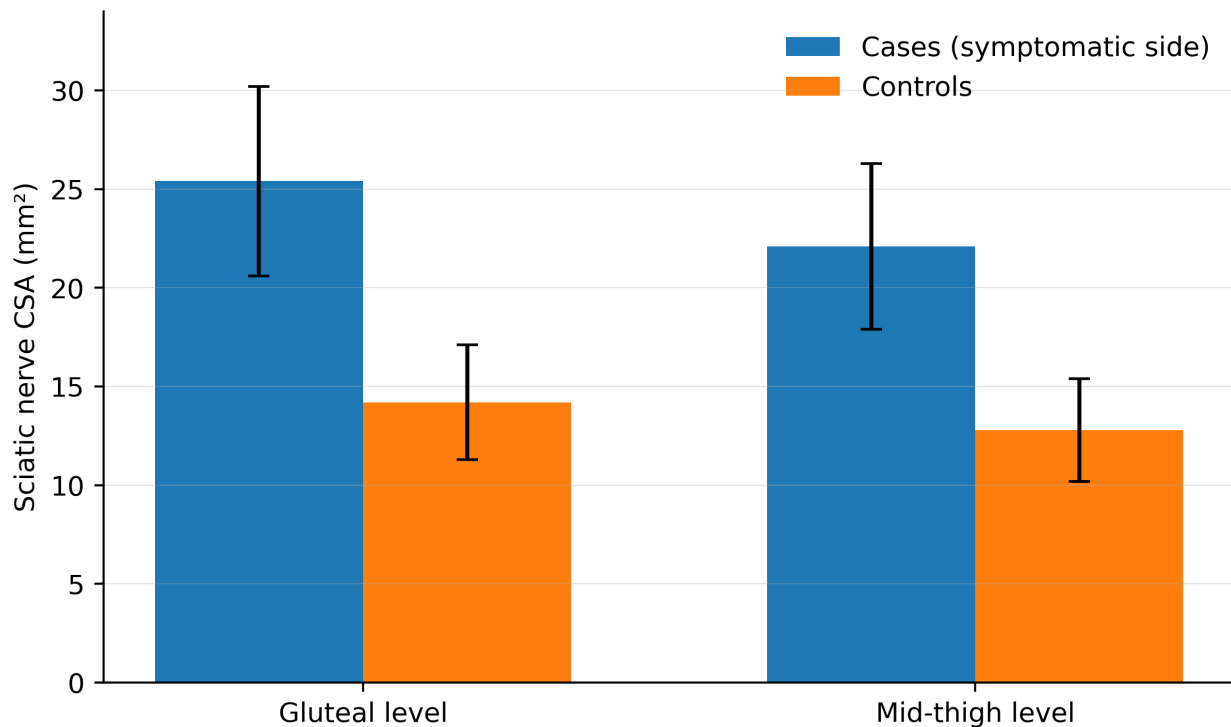


Figure 1. Mean sciatic nerve cross-sectional area at the gluteal and mid-thigh levels in cases and controls. Error bars represent standard deviations.

Associations with ergonomic exposures

All assessed ergonomic exposures showed positive correlations with symptomatic-side sciatic nerve CSA (Table 3). Daily sitting duration had the strongest correlation ($r = 0.69$), followed by forward-flexion score and years of occupational exposure. In the

adjusted model, sitting for >7 hours/day (OR 2.8, 95% CI 1.7–4.6), a forward-flexion score >3 (OR 2.4, 95% CI 1.5–3.9), and >15 lifts/day (OR 2.1, 95% CI 1.3–3.4) remained associated with case status.

Table 3. Correlation between ergonomic exposures and sciatic nerve cross-sectional area

Ergonomic exposure	Correlation (r)	p value
Daily sitting duration	0.69	<0.001
Forward-flexion posture score	0.64	<0.001
Repetitive lifting frequency	0.58	<0.001
Poor workstation ergonomics score	0.53	<0.001
Years of occupational exposure	0.61	<0.001

Correlations were calculated against symptomatic-side sciatic nerve CSA.

Discriminative performance of CSA

Gluteal CSA showed an area under the ROC curve of 0.94. A study-specific cutoff of ≥ 18.5 mm² provided 90.0% sensitivity

and 87.5% specificity. Mid-thigh CSA showed slightly lower but still high discrimination (Table 4).

Table 4. ROC-derived discriminative performance of sciatic nerve cross-sectional area

Measurement site	Optimal CSA cutoff	AUC	Sensitivity	Specificity	p value
Gluteal level	≥ 18.5 mm ²	0.94	90.0%	87.5%	<0.001
Mid-thigh level	≥ 16.5 mm ²	0.92	87.5%	85.0%	<0.001

AUC, area under the receiver operating characteristic curve; CSA, cross-sectional area.

DISCUSSION

This analytical case-control study yielded three principal findings. First, workers with unilateral sciatica had substantially larger symptomatic-side sciatic nerve CSA at the gluteal and mid-thigh levels than asymptomatic controls. Second, side-to-side asymmetry and abnormal echotexture were common in cases. Third, CSA increased in parallel with several modifiable ergonomic exposures, particularly prolonged sitting and sustained forward flexion.

The observed enlargement and loss of normal fascicular architecture are consistent with the structural abnormalities

described in peripheral nerve ultrasound literature. HRUSG can complement clinical assessment by showing nerve calibre and internal architecture in real time, although it does not by itself identify the biological cause of swelling. Quantitative work on nerve echogenicity and fascicular analysis further supports interpretation beyond CSA alone.^{25–27}

The strong side-to-side difference is clinically useful in unilateral symptoms because the contralateral nerve provides an internal comparator. Nevertheless, absolute values should be interpreted cautiously. Published reference studies show that CSA varies by measurement level, body habitus, and population, and even technically reliable bilateral measurements depend on consistent

probe position and pressure.^{20–24} The 18.5 mm² gluteal cutoff in this study should therefore be considered sample-specific rather than a universal diagnostic threshold.

The exposure findings align with occupational evidence linking lifting, bending, whole-body vibration, and cumulative mechanical load with low-back pain and sciatica.^{8–10} They also reinforce that sitting should be interpreted together with posture, breaks, workstation design, and individual susceptibility rather than as an isolated exposure.^{11–12} The associations support ergonomic assessment as part of clinical evaluation and provide a rationale for prospective studies of workstation redesign, activity breaks, lifting retraining, task rotation, and exercise-based programs.^{13–15}

HRUSG should be viewed as an adjunct rather than a replacement for a complete neurological and spinal evaluation. Buttock-predominant or extraspinal symptoms may reflect deep-gluteal or piriformis-related pathology, and targeted imaging of the surrounding anatomy may be required.^{28–30} MRI or electrodiagnostic testing remains appropriate when red flags, progressive deficits, diagnostic uncertainty, or discordant findings are present.

A strength of this study was the bilateral assessment at two anatomical levels together with quantitative exposure measures and ROC analysis. The findings generate clinically testable hypotheses about whether reducing ergonomic burden can alter symptoms or nerve morphology. However, the current data establish association only and should not be interpreted as proof that the measured workplace exposures caused the ultrasound abnormalities.

LIMITATIONS

The study had several limitations. Its single-centre case-control design did not establish temporal sequence or causality. The modest sample size and selected case-control spectrum may have increased apparent diagnostic performance and limited the stability of multivariable estimates. Ergonomic exposures were based on a structured assessment but were not supported by direct workplace observation or objective exposure monitoring. Examiner blinding and interobserver reliability were not evaluated. Excluding MRI-confirmed lumbar disc prolapse improved etiological specificity but reduced applicability to mixed clinical sciatica. Finally, the CSA cutoffs were derived and tested in the same sample and require external validation in larger, prospectively recruited populations.

CONCLUSION

Workers with unilateral sciatica had greater sciatic nerve CSA, more pronounced side-to-side asymmetry, and more frequent abnormal echotexture than asymptomatic controls. Ultrasound findings correlated with prolonged sitting, forward flexion, repetitive lifting, poor workstation ergonomics, and occupational exposure duration. HRUSG may provide an objective adjunct for structural assessment and risk stratification, but the observed associations and thresholds should be confirmed prospectively before use for screening or causal attribution.

ACKNOWLEDGEMENT

Nil.

ETHICAL APPROVAL

Ethical approval was obtained from the Saveetha Research Board, and written informed consent was obtained from all participants.

AUTHOR CONTRIBUTIONS

Both authors contributed to study conception, data interpretation, manuscript drafting, critical revision, and final approval of the manuscript.

REFERENCE

1. Ferreira ML, de Luca K, Haile LM, et al. Global, regional, and national burden of low back pain, 1990–2020, its attributable risk factors, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021. *Lancet Rheumatol.* 2023;5(6):e316–e329. DOI: 10.1016/S2665-9913(23)00098-X.
2. Hartvigsen J, Hancock MJ, Kongsted A, et al. What low back pain is and why we need to pay attention. *Lancet.* 2018;391(10137):2356–2367. DOI: 10.1016/S0140-6736(18)30480-X.
3. Koes BW, van Tulder MW, Peul WC. Diagnosis and treatment of sciatica. *BMJ.* 2007;334(7607):1313–1317. DOI: 10.1136/bmj.39223.428495.BE.
4. Koes BW. Improving the management of sciatica. *Lancet Rheumatol.* 2020;2(7):e372–e373. DOI: 10.1016/S2665-9913(20)30130-2.
5. National Institute for Health and Care Excellence. Low back pain and sciatica in over 16s: assessment and management. NICE Guideline NG59. London: NICE; 2020 update.
6. George SZ, Fritz JM, Silfies SP, et al. Interventions for the management of acute and chronic low back pain: revision 2021. *J Orthop Sports Phys Ther.* 2021;51(11):CPG1–CPG60. DOI: 10.2519/jospt.2021.0304.
7. Thoomes E, Falla D, Cleland JA, Fernandez-de-las-Penas C, Gallina A, de Graaf M. Conservative management for lumbar radiculopathy based on the stage of the disorder: a Delphi study. *Disabil Rehabil.* 2023;45(21):3539–3548. DOI: 10.1080/09638288.2022.2130448.
8. Jahn A, Andersen JH, Christiansen DH, Seidler A, Dalboge A. Occupational mechanical exposures as risk factor for chronic low-back pain: a systematic review and meta-analysis. *Scand J Work Environ Health.* 2023;49(7):453–465. DOI: 10.5271/sjweh.4114.
9. Jahn A, Andersen JH, Seidler A, Christiansen DH, Dalboge A. Occupational psychosocial exposures and chronic low-back pain: a systematic review and meta-analysis. *Scand J Work Environ Health.* 2024;50(5):329–340. DOI: 10.5271/sjweh.4165.
10. Euro U, Heliovaara M, Shiri R, Knekt P, Rissanen H, Aromaa A, Karppinen J. Work-related risk factors for sciatica leading to hospitalization. *Sci Rep.* 2019;9(1):6562. DOI: 10.1038/s41598-019-42597-w.
11. Eisele-Metzger A, Schoser DS, Klein MD, et al. Interventions for preventing back pain among office workers: a systematic review and network meta-analysis. *Scand J Work Environ Health.* 2023;49(1):5–22. DOI: 10.5271/sjweh.4070.
12. Alaca N, Kara A, Akinoglu B, Kocahan T. Low back pain and sitting time, posture and behavior in office workers: a scoping review. *Work.* 2025. DOI: 10.1177/10538127251320320.
13. Santos W, Rojas C, Isidoro R, et al. Efficacy of ergonomic interventions on work-related musculoskeletal pain: a systematic review and meta-analysis. *J Clin Med.* 2025;14(9):3034. DOI: 10.3390/jcm14093034.
14. Russo F, Papalia GF, Vadala G, et al. The effects of workplace interventions on low back pain in workers: a systematic review and meta-analysis. *Int J Environ Res Public Health.* 2021;18(23):12614. DOI: 10.3390/ijerph182312614.
15. van de Wijdeven B, Visser B, Daams J, Kuijer PPFM. A first step towards a framework for interventions for individual working practice to prevent work-related musculoskeletal disorders: a scoping review. *BMC Musculoskelet Disord.* 2023;24(1):87. DOI: 10.1186/s12891-023-06155-w.
16. Carroll AS, Simon NG. Current and future applications of ultrasound imaging in peripheral nerve disorders. *World J Radiol.* 2020;12(6):101–129. DOI: 10.4329/wjr.v12.i6.101.
17. Nouh MR, Abdel-Naby HM, El Sakka T, El-Shafei M. Peripheral nerve ultrasound: a survival guide for the practicing radiologist with updates. *Ultrasound J.* 2025;17:21. DOI: 10.1186/s13089-024-00387-0.

18. Nischal N, Gupta S, Lal K, Singh JP. Performance evaluation of high-resolution ultrasound versus magnetic resonance imaging in diagnosing peripheral nerve pathologies. *Indian J Radiol Imaging*. 2021;31(1):43–48. DOI: 10.1055/s-0041-1729130.
19. Agarwal A, Chandra A, Jaipal U, et al. Can imaging be the new yardstick for diagnosing peripheral neuropathy? A comparison between high-resolution ultrasound and MR neurography with an approach to diagnosis. *Insights Imaging*. 2019;10:104. DOI: 10.1186/s13244-019-0787-6.
20. Cartwright MS, Passmore LV, Yoon JS, Brown ME, Caress JB, Walker FO. Cross-sectional area reference values for nerve ultrasonography. *Muscle Nerve*. 2008;37(5):566–571. DOI: 10.1002/mus.21009.
21. Fisse AL, Katsanos AH, Gold R, Krogias C, Pitarokoili K. Cross-sectional area reference values for peripheral nerve ultrasound in adults: a systematic review and meta-analysis—Part II: lower extremity nerves. *Eur J Neurol*. 2021;28(7):2313–2318. DOI: 10.1111/ene.14850.
22. Hsieh PC, Chang KH, Wu YR, et al. Cross-sectional area reference values for sonography of peripheral nerves in Taiwanese adults. *Front Neurol*. 2021;12:722403. DOI: 10.3389/fneur.2021.722403.
23. Singh KP, Singh P, Gupta K. Reference values for the cross-sectional area of the normal sciatic nerve using high-resolution ultrasonography. *J Ultrason*. 2021;21(85):e95–e101. DOI: 10.15557/JoU.2021.0018.
24. Tagliafico A, Cadoni A, Fisci E, Bignotti B, Padua L, Martinoli C. Reliability of side-to-side ultrasound cross-sectional area measurements of lower extremity nerves in healthy subjects. *Muscle Nerve*. 2012;46(5):717–722. DOI: 10.1002/mus.23417.
25. Gamber D, Motte J, Kerasnoudis A, et al. High-resolution nerve ultrasound to assess nerve echogenicity, fascicular count, and cross-sectional area using semiautomated analysis. *J Neuroimaging*. 2020;30(4):493–502. DOI: 10.1111/jon.12717.
26. Grusauskiene E, Kerasnoudis A, Petrikonis K, et al. Cross-sectional area and echogenicity reference values of peripheral nerves in a Lithuanian cohort. *Diagnostics*. 2024;14(13):1373. DOI: 10.3390/diagnostics14131373.
27. Erdmann A, Kerasnoudis A, Pitarokoili K, et al. Nerve echogenicity in polyneuropathies of various origins. *Diagnostics*. 2022;12(6):1341. DOI: 10.3390/diagnostics12061341.
28. Manske RC, Wolfe C, Page P, Voight M, Bardowski B. Use of diagnostic musculoskeletal ultrasound in the evaluation of piriformis syndrome: a review for rehabilitation providers. *Int J Sports Phys Ther*. 2024;19(6):768–772. DOI: 10.26603/001c.118145.
29. Koh E. Imaging of peripheral nerve causes of chronic buttock pain and sciatica. *Clin Radiol*. 2021;76(8):626.e1–626.e11. DOI: 10.1016/j.crad.2021.03.005.
30. Siahaan YMT, Tiffani P, Tarigan TJ, et al. Ultrasound-guided measurement of piriformis muscle thickness to diagnose piriformis syndrome. *Front Neurol*. 2021;12:721966. DOI: 10.3389/fneur.2021.721966.