

Data Mining-Based Analysis of Acupoint Selection Patterns in Acupuncture Treatment for Lumbar Disc Herniation

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Background: Lumbar disc herniation (LDH) poses a significant global health burden, with lifetime prevalence rates reaching 40%. While acupuncture is widely used for LDH, the heterogeneity in acupoint selection hinders the standardization of treatment protocols. This study aimed to systematically screen clinical literature and utilize data mining techniques to identify core acupoint combinations and therapeutic strategies for LDH.

Methods: A comprehensive systematic search was conducted across seven electronic databases (PubMed, The Cochrane Library, Web of Science, SinoMed, CNKI, Wanfang, and VIP) from inception to January 2025. Descriptive statistics were analyzed using Microsoft Excel 2023. Association rule mining was performed via R Studio (v4.3.0, *arules* package) using the Apriori algorithm (support ≥ 0.07 , confidence ≥ 0.6). Hierarchical cluster analysis was conducted in SPSS Statistics (v26.0) employing Ward's linkage method with squared Euclidean distance to group high-frequency acupoints. Additionally, neural distribution analysis was performed to map acupoint-nerve relationships.

Results: A total of 537 studies were included, comprising 766 distinct acupuncture prescriptions and 149 unique acupoints. Frequency analysis showed that 13 core acupoints accounted for 74.65% of total usage, with Weizhong (BL40, 9.68%), Huantiao (GB30, 8.47%), and Dachangshu (BL25, 8.30%) being most frequently utilized. The Bladder meridian was the most frequently used channel (57.68%). Association rule analysis yielded 449 core rules, identifying the Weizhong (BL40)-Dachangshu (BL25) pair as the strongest combination (support: 42.43%). Cluster analysis delineated six distinct therapeutic strategies, with the core Bladder meridian cluster demonstrating the highest clinical significance. Neural distribution analysis indicated predominant involvement of lumbar nerves (25.72%) and the sciatic nerve complex (22.55%).

Conclusion: This study presents a comprehensive data mining analysis of acupuncture for LDH. Although constrained by the heterogeneity of included studies and data limitations, the revealed core combinations provide valid quantitative evidence to support the standardization of treatment protocols and inform clinical decision-making.

Keywords: lumbar disc herniation, acupuncture, data mining, association rules, cluster analysis, neural distribution, acupoint selection

Introduction

Lumbar disc herniation (LDH) represents one of the most prevalent degenerative spinal disorders, characterized by the protrusion or extrusion of intervertebral disc material beyond the normal disc space, resulting in compression of adjacent nerve roots and subsequent neurological dysfunction.¹ The global burden of LDH is substantial, with epidemiological studies indicating that it affects approximately 2–3% of the general population annually, with lifetime prevalence rates reaching up to 40%.^{2,3} This condition predominantly affects individuals between 30 and 50 years of age, representing the most economically productive demographic.⁴ The clinical manifestations of LDH include lower back pain, radicular

pain, neurological deficits, and functional disability, which collectively impose significant restrictions on patients' quality of life, work capacity, and social functioning.⁵ The economic impact extends beyond individual suffering, with LDH contributing substantially to healthcare expenditures, disability claims, and productivity losses, making it a leading cause of years lived with disability globally.⁵ Current conventional treatment approaches encompass conservative management through pharmacological interventions, physical therapy, and epidural injections, with surgical intervention reserved for severe or refractory cases.⁶ However, these traditional therapies are often associated with limitations including adverse drug reactions, incomplete symptom resolution, high recurrence rates, and potential surgical complications, necessitating the exploration of effective, minimally invasive complementary therapeutic modalities.⁷

Acupuncture, as a core component of Traditional Chinese Medicine, has gained widespread recognition and acceptance as an effective complementary therapy for managing LDH-related symptoms.⁸ Numerous clinical trials and systematic reviews have demonstrated the efficacy of acupuncture in alleviating pain intensity, improving functional outcomes, and enhancing quality of life in patients with LDH.^{8–10} Recent meta-analyses have provided robust evidence supporting acupuncture's therapeutic benefits, showing significant improvements in pain scores, functional disability indices, and overall treatment response rates compared to conventional therapies alone.^{6,8} The underlying mechanisms of acupuncture's therapeutic effects involve complex neurophysiological processes, including modulation of pain signaling pathways at peripheral, spinal, and supraspinal levels, promotion of endogenous opioid release, and regulation of inflammatory mediators.^{11,12} Additionally, acupuncture has been shown to improve local blood circulation, reduce muscle tension, and facilitate nerve regeneration, all of which contribute to symptomatic relief and functional recovery in LDH patients.^{13–15} However, clinical outcomes in acupuncture treatment demonstrate considerable variability, which may be attributed to differences in acupoint selection, needle manipulation techniques, treatment frequency, and the specific combinations of acupoints employed across different practitioners and research studies.

Despite the growing body of evidence supporting acupuncture's efficacy in LDH management, significant variability exists in acupoint selection and prescription patterns across different clinical studies and practitioners.¹⁶ This heterogeneity in treatment protocols poses challenges for clinical practice standardization and research reproducibility. Different acupuncturists may select varying combinations of acupoints based on their individual training, clinical experience, and theoretical understanding of Traditional Chinese Medicine principles.¹⁰ The lack of standardized acupoint selection criteria not only limits the comparability of clinical trial outcomes but also creates uncertainty for practitioners seeking data-driven reference for optimal treatment protocols. Furthermore, the specificity of individual acupoints and the potential synergistic effects of acupoint combinations remain poorly understood, with limited quantitative evidence available to guide systematic acupoint prescription in LDH treatment.¹⁷

Data mining technologies have emerged as powerful analytical tools capable of extracting meaningful patterns and relationships from large, complex datasets, offering unprecedented opportunities to advance data-driven acupuncture research.¹⁸ The application of data mining techniques in acupuncture research has demonstrated remarkable success in identifying core acupoint selections and optimal treatment combinations across various medical conditions. Previous studies have successfully employed data mining approaches to analyze acupoint prescription patterns in diverse disorders, including carpal tunnel syndrome, chronic stable angina pectoris, obesity, chemotherapy-induced peripheral neuropathy, tic disorders, and chronic pain syndromes.¹⁹ These investigations have revealed valuable insights into acupoint specificity, combination rules, and treatment optimization strategies, providing objective, quantitative evidence to support clinical decision-making. The methodological advantages of data mining include its capacity to process large volumes of clinical data, identify hidden patterns that may not be apparent through traditional analytical methods, and generate reproducible, data-driven recommendations for acupoint selection. Such systematic approaches can bridge the gap between traditional empirical knowledge and modern data-driven medicine, facilitating the standardization and optimization of acupuncture treatment protocols.^{20,21}

Our study aims to comprehensively analyze the acupoint selection patterns and combinations employed in acupuncture treatment for LDH through advanced data mining techniques, including association rule mining, frequency analysis, cluster analysis, and network analysis. This investigation seeks to identify the core acupoints most frequently utilized in LDH treatment, elucidate the underlying combination rules governing acupoint prescription, and establish data-driven references for standardized acupuncture protocols. The expected contributions of this research include the revelation of

systematic patterns in acupoint selection that reflect collective clinical wisdom, the identification of optimal acupoint combinations that maximize therapeutic efficacy, and the provision of objective, quantitative evidence to support clinical decision-making in acupuncture practice. Furthermore, this study will contribute to the scientific understanding of acupuncture mechanisms by revealing the rational basis for traditional acupoint prescription patterns and their relationship to neuroanatomical structures. The findings are anticipated to serve as a valuable reference for acupuncture practitioners, inform the design of future clinical trials, and advance the standardization of acupuncture treatment protocols for LDH. This research represents a crucial step toward integrating traditional acupuncture wisdom with modern analytical methodologies, ultimately contributing to the data-driven reference of acupuncture practice in lumbar disc herniation management.

Materials and Methods

Literature Search Strategy

A comprehensive systematic literature search was conducted to identify all relevant studies investigating acupuncture treatment for lumbar disc herniation (LDH) published from January 1, 2010, to January 1, 2025. Seven electronic databases were systematically searched: China National Knowledge Infrastructure (CNKI), Wanfang Data, VIP Database, SinoMed, PubMed, Web of Science, and The Cochrane Library. The search strategy was developed in consultation with a medical librarian and combined subject headings and free-text terms related to acupuncture interventions and lumbar disc herniation.

The search terms included combinations of the following keywords: “Intervertebral disc disease”, “LDH”, “Lumbar herniated disc”, “Lumbar disc herniation”, “Lumbar radiculopathy”, “Acupuncture”. Language restrictions were applied to include only studies published in English and Chinese. The complete search strategies for each database are provided in [Supplementary Table 1](#). Additionally, reference lists of included studies and relevant systematic reviews were manually searched to identify any additional eligible studies that may have been missed in the electronic search.

Study Selection Criteria

Inclusion Criteria

Studies were eligible for inclusion if they met the following criteria: (1) study design: randomized controlled trials (RCTs), quasi-randomized controlled trials, or observational studies (cohort studies, case-control studies, and case series); (2) participants: patients aged 18 years or older with a definitive diagnosis of LDH confirmed by imaging studies (magnetic resonance imaging, computed tomography, or myelography) and based on internationally recognized diagnostic criteria such as those from the North American Spine Society or similar authoritative guidelines; (3) intervention: studies in which acupuncture—including manual acupuncture, electroacupuncture, warm needle acupuncture, or acupuncture combined with moxibustion—was used as the primary therapeutic intervention, either as monotherapy or in combination with conventional treatments; (4) outcome measures: studies that employed standardized and validated efficacy evaluation indicators such as pain intensity scales (Visual Analog Scale, Numeric Rating Scale), functional disability measures (Oswestry Disability Index, Roland-Morris Disability Questionnaire), or neurological assessment tools; and (5) study quality: studies with clearly described methodology and adequate reporting of acupuncture interventions according to the Standards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA) guidelines.¹

Exclusion Criteria

Studies were excluded based on the following criteria: (1) incomplete or inadequately described acupuncture prescriptions that did not specify exact acupoint locations or treatment parameters; (2) studies in which acupuncture was used only as an adjunctive therapy without clear reporting of its specific contribution to treatment outcomes; (3) absence of clear diagnostic criteria for LDH or lack of standardized effectiveness indicators; (4) use of non-standard acupoint locations that deviated from World Health Organization (WHO) Standard Acupuncture Point Locations or unconventional acupoint selection strategies without proper justification; (5) studies with insufficient sample size (< 30 participants per group) that would limit statistical power and generalizability of findings; (6) duplicate publications, conference

abstracts without full-text availability, case reports with fewer than 10 cases, and review articles; (7) studies involving participants with other spinal conditions that could confound the results; and (8) studies with high risk of bias as determined by methodological quality assessment.

Study Selection Process

The study selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Initial screening was performed by removing duplicate records using NoteExpress 4.1.0 software. Two independent reviewers (initials blinded) conducted title and abstract screening using predefined eligibility criteria. Full-text articles of potentially eligible studies were then retrieved and independently assessed for inclusion. Any disagreements between reviewers were resolved through discussion, and when necessary, a third senior reviewer was consulted to reach consensus. The inter-rater agreement was calculated using Cohen's kappa coefficient. A detailed PRISMA flow diagram documenting the study selection process is presented in [Figure 1](#).

Data Extraction

A standardized data extraction form was developed and pilot-tested on a sample of included studies. Two reviewers independently extracted data from each included study using this form. The following information was systematically extracted: (1) study characteristics: first author, publication year, country, study design, sample size, and follow-up duration; (2) participant characteristics: age, gender distribution, duration of symptoms, severity of LDH, and baseline functional status; (3) intervention details: specific acupoints used, needle specifications, stimulation methods, treatment frequency and duration, practitioner qualifications, and co-interventions; (4) control group interventions: type of control (sham acupuncture, conventional treatment, or waitlist), and specific details of control interventions; (5) outcome measures: primary and secondary outcomes, measurement tools used, and timing of assessments; and (6) results: treatment effects, adverse events, and dropout rates.

For the purpose of acupoint analysis, only primary acupoints were extracted from the acupuncture prescriptions, defined as those acupoints consistently used across all participants in the treatment protocol. Adjunct acupoints selected based on traditional Chinese medicine syndrome differentiation or individualized treatment strategies were excluded to ensure consistency and facilitate meaningful analysis of core acupoint combinations.

Data Standardization and Validation

All extracted acupoint names and meridian classifications were standardized according to the national textbook "Meridians and Acupoints" from the 14th Five-Year Plan and cross-referenced with the WHO Standard Acupuncture Point Locations to ensure international consistency. This standardization process involved: (1) converting all acupoint names to their internationally recognized codes (eg, DU20, ST36); (2) verifying anatomical locations according to standardized anatomical landmarks; (3) categorizing acupoints by their meridian affiliations according to traditional Chinese medicine theory; (4) classifying acupoints by their anatomical regions (cervical, thoracic, lumbar, sacral, and extremities); and (5) identifying the primary nerve distributions and innervation patterns for each acupoint based on modern anatomical knowledge.

The standardization process was conducted by two researchers with expertise in acupuncture and traditional Chinese medicine, with any discrepancies resolved through consultation with senior acupuncture practitioners and reference to authoritative acupuncture texts.

Statistical Analysis Methods

Descriptive statistics were performed using Microsoft Excel 2023 to summarize the characteristics of included studies and analyze the frequency of individual acupoints and acupoint combinations. Frequency analysis was conducted to identify the most commonly used acupoints, with results presented as absolute frequencies and relative percentages.

Association rule mining was performed using the *arules* package in R Studio (version 4.3.0) to identify patterns and associations among acupoint combinations. The analysis employed the Apriori algorithm with minimum support and confidence thresholds set at 0.07 and 0.6, respectively, to identify meaningful associations while maintaining statistical

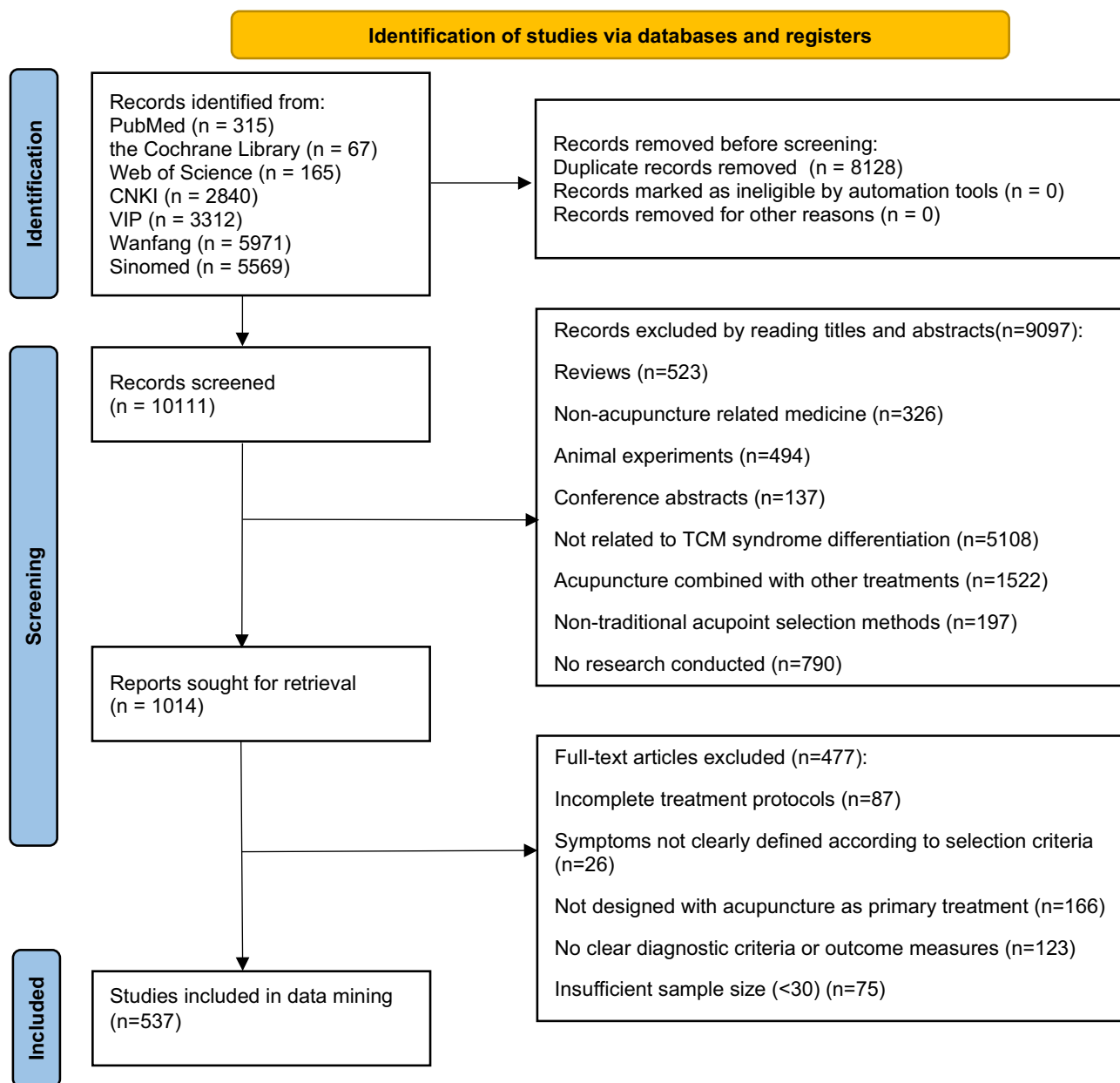


Figure 1 PRISMA flow diagram of the literature selection process. The flowchart illustrates the detailed screening procedure, including identification, screening, eligibility, and final inclusion of studies regarding acupuncture treatment for lumbar disc herniation (LDH).

reliability. Key measures calculated included support (frequency of acupoint combinations), confidence (conditional probability of acupoint co-occurrence), and lift (strength of association between acupoints, where a lift value greater than 1 suggests a stronger than random association between acupoints). Hierarchical cluster analysis was conducted using SPSS Statistics version 26.0 to group high-frequency acupoints (defined as those appearing in 10 or more studies). We employed Ward's linkage method with squared Euclidean distance as the similarity measure. This method was selected because it minimizes the total within-cluster variance, making it suitable for grouping similar acupoints based on their co-occurrence patterns. The optimal number of clusters was determined using dendrogram interpretation and the elbow method, which visually identifies the point where adding more clusters no longer significantly reduces the total within-cluster variance. Finally, heat maps and network diagrams were generated to visualize the acupoint relationships and clustering patterns.

Ethical Considerations

As this study involved analysis of previously published literature and did not include primary data collection from human subjects, ethical approval was not required. However, all data extraction and analysis procedures were conducted in accordance with established guidelines for data mining studies.

Results

Literature Search and Selection Process

A comprehensive systematic search identified 10,111 articles related to acupuncture treatment for lumbar disc herniation (LDH) across seven electronic databases: CNKI, Wanfang Data, VIP Database, SinoMed, PubMed, Web of Science, and The Cochrane Library. Following duplicate removal using NoteExpress 4.1.0 software, 1014 articles underwent initial screening. After applying the predetermined inclusion and exclusion criteria, 537 studies were ultimately included in the analysis. These studies encompassed 766 distinct acupuncture prescriptions and documented the use of 149 unique acupoints. The inter-rater agreement for study selection was excellent ($\kappa = 0.89$). The complete literature selection process is illustrated in the PRISMA flow diagram (Figure 1).

Acupoint Usage Frequency Analysis

Individual Acupoint Frequency

Among the 149 identified acupoints, the cumulative usage frequency totaled 5219 occurrences. Thirteen acupoints demonstrated exceptional clinical significance, each being used more than 100 times and collectively accounting for 3896 occurrences (74.65% of total usage). The top-ranking acupoints were Weizhong (BL40, $n = 505$, 9.68%), Huantiao (GB30, $n = 442$, 8.47%), and Dachangshu (BL25, $n = 433$, 8.30%). These were followed by Shenshu (BL23, $n = 417$, 7.99%), Jiaji (EX-B2, $n = 407$, 7.80%), Yanglingquan (GB34, $n = 332$, 6.36%), Ashi points ($n = 260$, 4.98%), Kunlun (BL60, $n = 222$, 4.25%), Yaoyangguan (DU3, $n = 205$, 3.93%), Zhibian (BL54, $n = 196$, 3.76%), Chengshan (BL57, $n = 188$, 3.60%), Xuanzhong (GB39, $n = 166$, 3.18%), and Guanyuanshu (BL26, $n = 123$, 2.36%) (Figure 2). The distribution pattern revealed a clear preference for specific acupoints, with the top 5 acupoints accounting for 42.25% of all usage, and the top 13 accounting for nearly three-quarters of all acupoint applications. This indicates strong consensus among practitioners regarding core acupoint selection for LDH treatment.

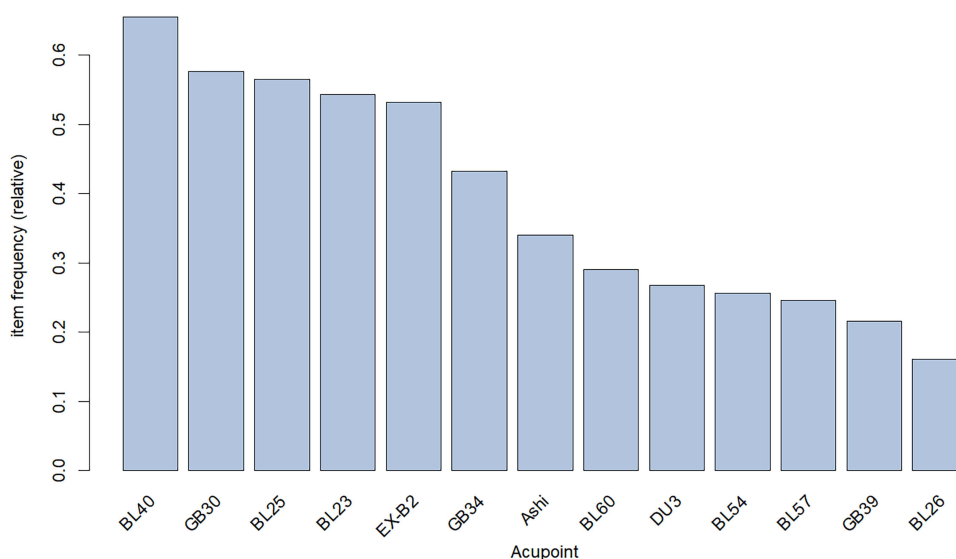


Figure 2 Frequency distribution of the top 13 high-frequency acupoints. The bar chart displays acupoints used in LDH treatment, ranked by frequency. Weizhong (BL40), Huantiao (GB30), and Dachangshu (BL25) were identified as the most frequently used acupoints.

Meridian Distribution Analysis

The meridian affiliation analysis revealed a pronounced concentration of acupoint usage within specific meridian systems. The Bladder meridian of Foot Taiyang dominated with 2591 occurrences (57.68% of total frequency) across 42 distinct acupoints (30.43% of all acupoints). This meridian's prominence was exemplified by key points including Weizhong (BL40), Dachangshu (BL25), and Shenshu (BL23), which collectively contributed to over 25% of total acupoint usage.

The Gallbladder meridian of Foot Shaoyang ranked second with 1170 occurrences (26.05%) distributed among 22 acupoints (15.94%), featuring pivotal points such as Huantiao (GB30), Yanglingquan (GB34), and Xuanzhong (GB39). The Governor Vessel contributed 347 occurrences (7.72%) across 12 acupoints (8.70%), with Yaoyangguan (DU3) and Mingmen (DU4) being the most frequently utilized.

Moderate representation was observed in the Conception Vessel (85 occurrences, 1.89%), Stomach meridian of Foot Yangming (130 occurrences, 2.89%), and Kidney meridian of Foot Shaoyin (58 occurrences, 1.29%). Conversely, the Hand Yang and Hand Yin meridians—including the Large Intestine, Small Intestine, Triple Energizer, Heart, and Pericardium meridians—showed minimal utilization, each contributing less than 1% of total frequency. This distribution pattern underscores the anatomical and functional relevance of the Bladder and Gallbladder meridians to lumbar pathology (Table 1).

Table 1 Distribution Characteristics of Acupoints by Meridian Affiliation in Lumbar Disc Herniation Treatment

Meridian Name	Frequency (n, %)	No. of Acupoints (n, %)	Acupoints (Frequency)
Governor Vessel (DU)	347 (7.72%)	12 (8.70%)	Yaoyangguan (DU3, 205), Mingmen (DU4, 84), Jizhong (DU6, 16), Yaoyu (DU2, 10), Baihui (DU20, 9), Changqiang (DU1, 8), Dazhui (DU14, 4), Shuigou (DU26, 4), Xuanshu (DU5, 3), Shenting (DU24, 2), Jinsu (DU8, 1), Zhongshu (DU7, 1)
Conception Vessel (RN)	85 (1.89%)	6 (4.35%)	Guanyuan (RN4, 30), Qihai (RN6, 26), Shuifen (RN9, 17), Zhongwan (RN12, 8), Xiawan (RN10, 3), Shangwan (RN13, 1)
Pericardium Meridian of Hand Jueyin (PC)	3 (0.07%)	2 (1.45%)	Neiguan (PC6, 2), Daling (PC7, 1)
Triple Energizer Meridian of Hand Shaoyang (SJ)	1 (0.02%)	1 (0.72%)	Waiguan (SJ5, 1)
Heart Meridian of Hand Shaoyin (HT)	1 (0.02%)	1 (0.72%)	Shenmen (HT7, 1)
Small Intestine Meridian of Hand Taiyang (SI)	32 (0.71%)	3 (2.17%)	Houxi (SI3, 26), Wanggu (SI4, 3), Yanglao (SI6, 3)
Large Intestine Meridian of Hand Yangming (LI)	11 (0.24%)	3 (2.17%)	Hegu (LI4, 6), Sanjian (LI3, 3), Quchi (LI11, 2)
Liver Meridian of Foot Jueyin (LR)	23 (0.51%)	6 (4.35%)	Taichong (LR3, 18), Dadun (LR1), Jimai (LR12), Ligou (LR5), Xingjian (LR2), Zhongdu (LR6)
Gallbladder Meridian of Foot Shaoyang (GB)	1170 (26.05%)	22 (15.94%)	Huantiao (GB30, 442), Yanglingquan (GB34, 332), Xuanzhong (GB39, 166), Fengshi (GB31, 99), Qiuxu (GB40, 49), Zulinqi (GB41, 22), Yangfu (GB38, 15), Xiyangguan (GB33, 12), Waiqiu (GB36, 7), Xiaxi (GB43, 5), Guangming (GB37, 4), Daimai (GB26, 3), Weidao (GB28, 3), Yangjiao (GB35, 2), Zuqiaoyin (GB44, 2), Fengchi (GB20, 1), Jianjing (GB21, 1), Jingmen (GB25, 1), Shangguan (GB3, 1), Tinghui (GB2, 1), Tongziliao (GB1, 1), Wushu (GB27, 1)

(Continued)

Table 1 (Continued).

Meridian Name	Frequency (n, %)	No. of Acupoints (n, %)	Acupoints (Frequency)
Kidney Meridian of Foot Shaoyin (KI)	58 (1.29%)	10 (7.25%)	Taixi (KI3, 30), Fuliu (KI7, 6), Qixue (KI13, 5), Dazhong (KI4, 4), Huangshu (KI16, 4), Zhaohai (KI6, 4), Shuquan (KI5, 2), Henggu (KI11, 1), Jiaoxin (KI8, 1), Zhubin (KI9, 1)
Bladder Meridian of Foot Taiyang (BL)	2591 (57.68%)	42 (30.43%)	Weizhong (BL40, 505), Dachangshu (BL25, 433), Shenshu (BL23, 417), Kunlun (BL60, 222), Zhibian (BL54, 196), Chengshan (BL57, 188), Guanyuanshu (BL26, 123), Yinmen (BL37, 83), Qihai Shu (BL24, 82), Chengfu (BL36, 73), Ciliao (BL32, 53), Geshu (BL17, 31), Xiaochangshu (BL27, 25), Feiyang (BL58, 23), Shangliao (BL31, 11), Fuyang (BL59, 10), Weiyang (BL39, 10), Zhishi (BL52, 9), Pangguangshu (BL28, 8), Chengjin (BL56, 8), Ganshu (BL18, 8), Shenmai (BL62, 8), Xialiao (BL34, 7), Zhongliao (BL33, 7), Zhiyin (BL67, 6), Heyang (BL55, 5), Sanjiaoshu (BL22, 5), Baihuanshu (BL30, 4), Dazhu (BL11, 4), Jinmen (BL63, 4), Pishu (BL20, 4), Shugu (BL65, 4), Weishu (BL21, 4), Jingming (BL1, 2), Zhonglushu (BL29, 2), Baohuang (BL53, 1), Feishu (BL13, 1), Fengmen (BL12, 1), Gaohuang (BL43, 1), Huiyang (BL35, 1), Jinggu (BL64, 1), Tianzhu (BL10, 1)
Spleen Meridian of Foot Taiyin (SP)	40 (0.89%)	8 (5.80%)	Sanyinjiao (SP6, 14), Xuehai (SP10, 11), Yinlingquan (SP9, 5), Gongsun (SP4, 3), Daheng (SP15, 2), Dijie (SP8, 2), Taibai (SP3, 2), Shangqiu (SP5, 1)
Stomach Meridian of Foot Yangming (ST)	130 (2.89%)	22 (15.94%)	Zusanli (ST36, 44), Futu (ST32, 14), Biguan (ST31, 13), Fenglong (ST40, 9), Liangqiu (ST34, 8), Jiexi (ST41, 5), Wailing (ST26, 5), Huaroumen (ST24, 4), Qichong (ST30, 4), Chongyang (ST42, 3), Shuidao (ST28, 3), Tianshu (ST25, 3), Yinshi (ST33, 3), Shangjuxu (ST37, 2), Taiyi (ST23, 2), Xiajuxu (ST39, 2), Daju (ST27, 1), Dubi (ST35, 1), Juliao (ST3, 1), Neiting (ST44, 1), Tiaokou (ST38, 1), Xiangu (ST43, 1)

Specific Acupoint Categories

Among the 149 acupoints, 85 were classified as specific acupoints according to traditional Chinese medicine theory, generating 3557 total occurrences. Back-Shu points demonstrated the highest utilization rate at 25.44% (905 occurrences), predominantly featuring Dachangshu (BL25) and Shenshu (BL23), which are traditionally associated with kidney and large intestine functions.

Lower He-Sea points followed closely with 25.16% (895 occurrences), primarily represented by Weizhong (BL40) and Yanglingquan (GB34). Traditional He-Sea points accounted for 24.96% (888 occurrences), with Weizhong (BL40) alone contributing more than half of this frequency, emphasizing its central role in treating lower back and leg conditions.

Shu-Stream points were broadly applied with 108 occurrences across 10 different acupoints, while Xi-Cleft points showed the greatest diversity, encompassing 11 types and constituting 12.94% of total usage. The Eight Influential Points, represented primarily by Xuanzhong (GB39), contributed 5.00% of occurrences, highlighting the importance of points that influence specific tissue types (Table 2).

Anatomical Distribution of Acupoints

The anatomical analysis revealed a strategic concentration of acupoint selection corresponding to the pathophysiology of LDH. Lower extremity acupoints predominated with 2522 occurrences (50.92%) across 61 distinct points (42.66% of all acupoints), reflecting the typical radiation pattern of LDH symptoms down the leg. Key representatives included Weizhong (BL40), Huantiao (GB30), and Yanglingquan (GB34).

The lumbar and back region contributed 2224 occurrences (44.90%) across 38 acupoints (26.57%), directly targeting the primary pathological site. This category was dominated by Dachangshu (BL25), Shenshu (BL23), and Jiaji (EX-B2), emphasizing local treatment approaches.

Table 2 Distribution of Specific Acupoint Categories and Their Therapeutic Attributes

Acupoint Category	Frequency (n, %)	No. of Acupoints (n, %)	Acupoints (Frequency)
Five Shu Points			
– Jing-Well	9 (0.25%)	3 (3.53%)	Zhiyin (BL67, 6), Zuqiaoyin (GB44, 2), Dadun (LR1, 1)
– Ying-Spring	7 (0.20%)	3 (3.53%)	Xiaxi (GB43, 5), Neiting (ST44, 1), Xingjian (LR2, 1)
– Shu-Stream	108 (3.04%)	10 (11.76%)	Taixi (KI3, 30), Houxi (SI3, 26), Zulinqi (GB41, 22), Taichong (LR3, 18), Shugu (BL65, 4), Sanjian (LI3, 3), Taibai (SP3, 2), Daling (PC7, 1), Shenmen (HT7, 1), Xiangu (ST43, 1)
– Jing-River	249 (7.00%)	5 (5.88%)	Kunlun (BL60, 222), Yangfu (GB38, 15), Fuliu (KI7, 6), Jiexi (ST41, 5), Shangqiu (SP5, 1)
– He-Sea	888 (24.96%)	5 (5.88%)	Weizhong (BL40, 505), Yanglingquan (GB34, 332), Zusanli (ST36, 44), Yinlingquan (SP9, 5), Quchi (LI11, 2)
Back-Shu Points	905 (25.44%)	9 (10.59%)	Dachangshu (BL25, 433), Shenshu (BL23, 417), Xiaochangshu (BL27, 25), Panguangshu (BL28, 8), Ganshu (BL18, 8), Sanjiaoshu (BL22, 5), Pishu (BL20, 4), Weishu (BL21, 4), Feishu (BL13, 1)
Luo-Connecting Points	55 (1.55%)	9 (10.59%)	Feiyang (BL58, 23), Fenglong (ST40, 9), Changqiang (DU1, 8), Dazhong (KI4, 4), Guangming (GB37, 4), Gongsun (SP4, 3), Neiguan (PC6, 2), Ligou (LR5, 1), Waiguan (SJ5, 1)
Yuan-Source Points	114 (3.20%)	10 (11.76%)	Qixu (GB40, 49), Taixi (KI3, 30), Taichong (LR3, 18), Hegu (LI4, 6), Chongyang (ST42, 3), Wanggu (SI4, 3), Taibai (SP3, 2), Daling (PC7, 1), Jinggu (BL64, 1), Shenmen (HT7, 1)
Eight Influential Points	178 (5.00%)	3 (3.53%)	Xuanzhong (GB39, 166), Zhongwan (RN12, 8), Dazhu (BL11, 4)
Lower He-Sea Points	895 (25.16%)	6 (7.06%)	Weizhong (BL40, 505), Yanglingquan (GB34, 332), Zusanli (ST36, 44), Weiyang (BL39, 10), Shangjuxu (ST37, 2), Xiajuxu (ST39, 2)
Eight Confluent Points	66 (1.86%)	7 (8.24%)	Houxi (SI3, 26), Zulinqi (GB41, 22), Shenmai (BL62, 8), Zhaohai (KI6, 4), Gongsun (SP4, 3), Neiguan (PC6, 2), Waiguan (SJ5, 1)
Front-Mu Points	42 (1.18%)	4 (4.71%)	Guanyuan (RN4, 30), Zhongwan (RN12, 8), Tianshu (ST25, 3), Jingmen (GB25, 1)
Xi-Cleft Points	41 (1.15%)	11 (12.94%)	Fuyang (BL59, 10), Liangqiu (ST34, 8), Waiqiu (GB36, 7), Jinmen (BL63, 4), Yanglao (SI6, 3), Dijie (SP8, 2), Shuiquan (KI5, 2), Yangjiao (GB35, 2), Jiaoxin (KI8, 1), Zhongdu (LR6, 1), Zhubin (KI9, 1)

The thoracoabdominal region accounted for a modest 128 occurrences (2.58%) across 22 acupoints (15.38%), primarily featuring constitutional strengthening points such as Guanyuan (RN4) and Qihai (RN6). Upper extremity and head/neck regions showed minimal representation, each contributing less than 1.5% of total usage, which aligns with the predominantly lower body manifestation of LDH symptoms (Table 3).

Neural Innervation Patterns

The neural distribution analysis revealed clinically relevant patterns corresponding to LDH pathophysiology. Lumbar nerves demonstrated the highest concentration with 1810 occurrences (25.72%) across 12 acupoints, directly correlating with the primary anatomical involvement in LDH. This was followed by the sciatic nerve complex, including the sciatic nerve itself (794 occurrences, 11.28%) and tibial nerve (793 occurrences, 11.27%), reflecting the common sciatic distribution of LDH symptoms.

The posterior femoral cutaneous nerve contributed 671 occurrences (9.54%), while the inferior gluteal nerve accounted for 638 occurrences (9.07%), both aligning with typical LDH pain radiation patterns. Thoracic nerves were associated with 444 occurrences (6.31%), primarily through Jiaji points (EX-B2), supporting the use of paravertebral approaches.

The common peroneal nerve (343 occurrences, 4.87%) and superficial peroneal nerve (266 occurrences, 3.78%) were well-represented, corresponding to lateral leg symptoms commonly seen in lateral disc herniations. This neural distribution pattern demonstrates a sophisticated understanding of the neuroanatomical basis of LDH symptoms and validates the targeted approach of acupoint selection (Table 4).

Table 3 Anatomical Distribution Characteristics of Acupoints Used in Lumbar Disc Herniation Treatment

Region	Frequency (n, %)	Number of Acupoints (n, %)	Representative Acupoints (Frequency)
Lower Extremities	2522 (50.92%)	61 (42.66%)	Weizhong (BL40, 505), Huantiao (GB30, 442), Yanglingquan (GB34, 332), Kunlun (BL60, 222), Chengshan (BL57, 188), Xuanzhong (GB39, 166), Fengshi (GB31, 99), Yinmen (BL37, 83), Chengfu (BL36, 73), Qiuxu (GB40, 49), Zusanli (ST36, 44), Taixi (KI3, 30), Feiyang (BL58, 23), Zulinqi (GB41, 22), Taichong (LR3, 18), Yangfu (GB38, 15), Futu (ST32, 14), Sanyinjiao (SP6, 14), Biguan (ST31, 13), Xiyangguan (GB33, 12), Xuehai (SP10, 11), Fuyang (BL59, 10), Weiyang (BL39, 10), Fenglong (ST40, 9), Chengjin (BL56, 8), Liangqiu (ST34, 8), Shenmai (BL62, 8), Waiqiu (GB36, 7), Fuli (KI7, 6), Zhiyin (BL67, 6), Heyang (BL55, 5), Jiexi (ST41, 5), Xiashi (GB43, 5), Yinlingquan (SP9, 5), Dazhong (KI4, 4), Guangming (GB37, 4), Jinmen (BL63, 4), Shugu (BL65, 4), Zhaohai (KI6, 4), Chongyang (ST42, 3), Gongsun (SP4, 3), Yinshi (ST33, 3), Dijii (SP8, 2), Shangjuxu (ST37, 2), Shuquan (KI5, 2), Taibai (SP3, 2), Xiajuxu (ST39, 2), Yangjiao (GB35, 2), Zuqiaoyin (GB44, 2), Dadun (LR1, 1), Dubi (ST35, 1), Jiaoxin (KI8, 1), Jinggu (BL64, 1), Ligou (LR5, 1), Neiting (ST44, 1), Shangqiu (SP5, 1), Tiaokou (ST38, 1), Xiang (ST43, 1), Xingjian (LR2, 1), Zhongdu (LR6, 1), Zhubin (KI9, 1)
Lumbar and Back	2224 (44.90%)	38 (26.57%)	Dachangshu (BL25, 433), Shenshu (BL23, 417), Jiaji (EX-B2, 407), Yaoyangguan (DU3, 205), Zhibian (BL54, 196), Guanyuanshu (BL26, 123), Mingmen (DU4, 84), Qihai (BL24, 82), Ciliao (BL32, 53), Geshu (BL17, 31), Shiqizhui (EX-B7, 28), Xiaochangshu (BL27, 25), Yaoyan (EX-B6, 18), Jizhong (DU6, 16), Shangliao (BL31, 11), Yaoyu (DU2, 10), Zhishi (BL52, 9), Pangguangshu (BL28, 8), Ganshu (BL18, 8), Changqiang (DU1, 8), Xialiao (BL34, 7), Zhongliao (BL33, 7), Sanjiaoshu (BL22, 5), Baihuanshu (BL30, 4), Dazhu (BL11, 4), Dazhui (DU14, 4), Pishu (BL20, 4), Weishu (BL21, 4), Xuanshu (DU5, 3), Zhonglushu (BL29, 2), Baohuang (BL53, 1), Feishu (BL13, 1), Fengmen (BL12, 1), Gaohuang (BL43, 1), Huiyang (BL35, 1), Jianjing (GB21, 1), Jinsu (DU8, 1), Zhongshu (DU7, 1)
Chest and Abdomen	128 (2.58%)	22 (15.38%)	Guanyuan (RN4, 30), Qihai (RN6, 26), Shuifen (RN9, 17), Zhongwan (RN12, 8), Qixue (KI13, 5), Wailing (ST26, 5), Huaroumen (ST24, 4), Huangshu (KI16, 4), Qichong (ST30, 4), Daimai (GB26, 3), Shuidao (ST28, 3), Tianshu (ST25, 3), Weidao (GB28, 3), Xiawan (RN10, 3), Daheng (SP15, 2), Taiyi (ST23, 2), Daju (ST27, 1), Henggu (KI11, 1), Jimai (LR12, 1), Jingmen (GB25, 1), Shangwan (RN13, 1), Wushu (GB27, 1)
Upper Extremities	55 (1.11%)	11 (7.69%)	Houxi (SI3, 26), Yaotongdian (EX-UE7, 7), Hegu (LI4, 6), Sanjian (LI3, 3), Wanggu (SI4, 3), Yanglao (SI6, 3), Neiguan (PC6, 2), Quchi (LI11, 2), Daling (PC7, 1), Shenmen (HT7, 1), Waiguan (SJ5, 1)
Head, Face, and Neck	24 (0.48%)	11 (7.69%)	Baihui (DU20, 9), Shuigou (DU26, 4), Jingming (BL1, 2), Shenting (DU24, 2), Fengchi (GB20, 1), Jingbailao (EX-HN14, 1), Juliao (ST3, 1), Shangguan (GB3, 1), Tianzhu (BL10, 1), Tinghui (GB2, 1), Tongziliao (GB1, 1)

Association Rule Mining Analysis

The association rule analysis using the Apriori algorithm identified 449 core association rules, with 24 rules meeting the criteria of usage frequency ≥ 150 and lift > 1 . Among these, 14 were two-acupoint combinations and 9 were three-acupoint combinations, indicating both simple and complex treatment strategies.

Table 4 Neural Innervation Patterns and Distribution Characteristics of Acupoints

Nerve	Frequency (n, %)	No. of Acupoints (n, %)	Representative Acupoints (Frequency)
Obturator nerve	1 (0.01%)	1 (0.53%)	Jimai (LR12, 1)
Ulnar nerve	40 (0.57%)	5 (2.66%)	Houxi (SI3, 26), Wanggu (SI4, 3), Yanglao (SI6, 3), Shenmen (HT7, 1), Yaotongdian (EX-UE7, 7)
Sacral nerve	117 (1.66%)	8 (4.26%)	Ciliao (BL32, 53), Shangliao (BL31, 11), Xialiao (BL34, 7), Zhongliao (BL33, 7), Baihuanshu (BL30, 4), Pangguangshu (BL28, 8), Xiaochangshu (BL27, 25), Zhonglushu (BL29, 2)
Sacrococcygeal nerve	19 (0.27%)	3 (1.60%)	Yaoyu (DU2, 10), Changqiang (DUI, 8), Huiyang (BL35, 1)
Frontal nerve	11 (0.16%)	2 (1.06%)	Shenting (DU24, 2), Baihui (DU20, 9)
Great auricular nerve	1 (0.01%)	1 (0.53%)	Tinghui (GB2, 1)
Sural nerve	240 (3.41%)	3 (1.60%)	Kunlun (BL60, 222), Fuyang (BL59, 10), Shenmai (BL62, 8)
Lateral sural cutaneous nerve	25 (0.36%)	2 (1.06%)	Feiyang (BL58, 23), Yangjiao (GB35, 2)
Superficial peroneal nerve	266 (3.78%)	12 (6.38%)	Xuanzhong (GB39, 166), Fenglong (ST40, 9), Guangming (GB37, 4), Waiqiu (GB36, 7), Yangfu (GB38, 15), Chongyang (ST42, 3), Jiexi (ST41, 5), Xiajuxu (ST39, 2), Qiuxu (GB40, 49), Gongsun (SP4, 3), Taibai (SP3, 2), Shangqiu (SP5, 1)
Deep peroneal nerve	77 (1.09%)	9 (4.79%)	Chongyang (ST42, 3), Jiexi (ST41, 5), Xiajuxu (ST39, 2), Dadun (LR1, 1), Xingjian (LR2, 1), Taichong (LR3, 18), Shangjuxu (ST37, 2), Tiaokou (ST38, 1), Zusanli (ST36, 44)
Common peroneal nerve	343 (4.87%)	3 (1.60%)	Yanglingquan (GB34, 332), Weiyang (BL39, 10), Dubi (ST35, 1)
Anal nerve	8 (0.11%)	1 (0.53%)	Changqiang (DUI, 8)
Posterior femoral cutaneous nerve	671 (9.54%)	4 (2.13%)	Weiyang (BL39, 10), Weizhong (BL40, 505), Chengfu (BL36, 73), Yinmen (BL37, 83)
Anterior femoral cutaneous nerve	36 (0.51%)	4 (2.13%)	Xuehai (SP10, 11), Futu (ST32, 14), Liangqiu (ST34, 8), Yinshi (ST33, 3)
Muscular branch of femoral nerve	110 (1.56%)	2 (1.06%)	Xuehai (SP10, 11), Fengshi (GB31, 99)
Lateral femoral cutaneous nerve	149 (2.12%)	6 (3.19%)	Futu (ST32, 14), Liangqiu (ST34, 8), Yinshi (ST33, 3), Biguan (ST31, 13), Fengshi (GB31, 99), Xiyangguan (GB33, 12)
Suprascapular nerve	31 (0.44%)	1 (0.53%)	Geshu (BL17, 31)
Cervical nerve	5 (0.07%)	2 (1.06%)	Dazhui (DU14, 4), Jingbailao (EX-HN14, 1)
Tibial nerve	793 (11.27%)	15 (7.98%)	Taichong (LR3, 18), Dazhong (KI4, 4), Shuquan (KI5, 2), Chengshan (BL57, 188), Chengjin (BL56, 8), Fuliu (KI7, 6), Heyang (BL55, 5), Zhubin (KI9, 1), Weizhong (BL40, 505), Diji (SP8, 2), Jiaoxin (KI8, 1), Taixi (KI3, 30), Yinlingquan (SP9, 5), Zhaohai (KI6, 4), Sanyinjiao (SP6, 14)
Intercostal nerve	107 (1.52%)	14 (7.45%)	Daheng (SP15, 2), Daju (ST27, 1), Huaroumen (ST24, 4), Huangshu (KI16, 4), Jingmen (GB25, 1), Tianshu (ST25, 3), Wailing (ST26, 5), Taiyi (ST23, 2), Guanyuan (RN4, 30), Qihai (RN6, 26), Shuifen (RN9, 17), Xiawan (RN10, 3), Zhongwan (RN12, 8), Shangwan (RN13, 1)
Subcostal nerve	11 (0.16%)	3 (1.60%)	Daimai (GB26, 3), Shuidao (ST28, 3), Qixue (KI13, 5)
Facial nerve	8 (0.11%)	5 (2.66%)	Tinghui (GB2, 1), Shuigou (DU26, 4), Juliao (ST3, 1), Shangguan (GB3, 1), Tongziliao (GB1, 1)

(Continued)

Table 4 (Continued).

Nerve	Frequency (n, %)	No. of Acupoints (n, %)	Representative Acupoints (Frequency)
Ilioinguinal nerve	8 (0.11%)	3 (1.60%)	Qichong (ST30, 4), Weidao (GB28, 3), Jimai (LR12, 1)
Iliohypogastric nerve	7 (0.10%)	3 (1.60%)	Qixue (KI13, 5), Wushu (GB27, 1), Henggu (KI11, 1)
Anterior interosseous nerve	1 (0.01%)	1 (0.53%)	Waiguan (SJ5, 1)
Cutaneous branches of forearm	7 (0.10%)	4 (2.13%)	Yanglao (SI6, 3), Shenmen (HT7, 1), Neiguan (PC6, 2), Daling (PC7, 1)
Radial nerve	18 (0.26%)	4 (2.13%)	Quchi (LI11, 2), Sanjian (LI3, 3), Yaotongdian (EX-UE7, 7), Hegu (LI4, 6)
Trigeminal nerve	9 (0.13%)	5 (2.66%)	Shuigou (DU26, 4), Juliao (ST3, 1), Shangguan (GB3, 1), Tongziliao (GB1, 1), Jingming (BL1, 2)
Supraclavicular nerve	1 (0.01%)	1 (0.53%)	Jianjing (GB21, 1)
Inferior gluteal nerve	638 (9.07%)	2 (1.06%)	Huantiao (GB30, 442), Zhibian (BL54, 196)
Thoracic nerve	444 (6.31%)	10 (5.32%)	Jiaji (EX-B2, 407), Ganshu (BL18, 8), Pishu (BL20, 4), Dazhu (BL11, 4), Feishu (BL13, 1), Fengmen (BL12, 1), Gaohuang (BL43, 1), Jizhong (DU6, 16), Jinsu (DU8, 1), Zhongshu (DU7, 1)
Thoracolumbar nerve	9 (0.13%)	2 (1.06%)	Sanjiaoshu (BL22, 5), Weishu (BL21, 4)
Optic nerve	2 (0.03%)	1 (0.53%)	Jingming (BL1, 2)
Lumbar nerve	1810 (25.72%)	12 (6.38%)	Jiaji (EX-B2, 407), Dachangshu (BL25, 433), Qihai Shu (BL24, 82), Shenshu (BL23, 417), Guanyuanshu (BL26, 123), Shiqizhui (EX-B7, 28), Yaoyan (EX-B6, 18), Zhishi (BL52, 9), Baohuang (BL53, 1), Mingmen (DU4, 84), Yaoyangguan (DU3, 205), Xuanshu (DU5, 3)
Axillary nerve	32 (0.45%)	2 (1.06%)	Geshu (BL17, 31), Jianjing (GB21, 1)
Pudendal nerve	5 (0.07%)	2 (1.06%)	Baihuanshu (BL30, 4), Huiyang (BL35, 1)
Saphenous nerve	52 (0.74%)	6 (3.19%)	Zusanli (ST36, 44), Ligou (LR5, 1), Zhongdu (LR6, 1), Gongsun (SP4, 3), Taibai (SP3, 2), Shangqiu (SP5, 1)
Greater occipital nerve	1 (0.01%)	1 (0.53%)	Tianzhu (BL10, 1)
Occipital nerve	9 (0.13%)	1 (0.53%)	Baihui (DU20, 9)
Lesser occipital nerve	1 (0.01%)	1 (0.53%)	Fengchi (GB20, 1)
Median nerve	9 (0.13%)	3 (1.60%)	Hegu (LI4, 6), Neiguan (PC6, 2), Daling (PC7, 1)
Dorsal digital nerves	2 (0.03%)	1 (0.53%)	Zuqiaoyin (GB44, 1)
Toe nerves	10 (0.14%)	2 (1.06%)	Shugu (BL65, 4), Zhiyin (BL67, 6)
Medial dorsal cutaneous nerve	2 (0.03%)	2 (1.06%)	Xiangu (ST43, 1), Neiting (ST44, 1)
Dorsal foot cutaneous nerve	49 (0.70%)	1 (0.53%)	Qiuxu (GB40, 49)
Lateral dorsal cutaneous nerve	15 (0.21%)	4 (2.13%)	Shugu (BL65, 4), Zhiyin (BL67, 6), Jinmen (BL63, 4), Jinggu (BL64, 1)
Intermediate dorsal cutaneous nerve	27 (0.38%)	2 (1.06%)	Zulinqi (GB41, 22), Xiaxi (GB43, 5)
Plantar nerves	5 (0.07%)	2 (1.06%)	Jinmen (BL63, 4), Jinggu (BL64, 1)
Sciatic nerve	794 (11.28%)	4 (2.13%)	Chengfu (BL36, 73), Yinmen (BL37, 83), Huantiao (GB30, 442), Zhibian (BL54, 196)

The highest support values were observed for: Weizhong (BL40) as a standalone point (support = 65.54%), the combination of Dachangshu (BL25) → Shenshu (BL23) (support = 43.08%, confidence = 76.21%), and Weizhong (BL40) → Dachangshu (BL25) (support = 42.43%, confidence = 64.74%). These findings suggest strong clinical consensus regarding core treatment combinations.

Notable high-confidence associations included Kunlun (BL60) → Weizhong (BL40) (confidence = 93.69%), Xuanzhong (GB39) → Yanglingquan (GB34) (confidence = 91.52%), and Jiaji (EX-B2) combined with Yanglingquan (GB34) → Huantiao (GB30) (confidence = 90.31%). These associations demonstrate reliable co-occurrence patterns that may represent established clinical protocols.

Table 5 High-Frequency Acupoint Association Rules with Support, Confidence, and Lift Values

Antecedent	Consequent	Support (n)	Support (%)	Confidence (%)
{}	{Weizhong (BL40)}	505	65.54%	65.54%
{Dachangshu (BL25)}	{Shenshu (BL23)}	330	43.08%	76.21%
{Weizhong (BL40)}	{Dachangshu (BL25)}	325	42.43%	64.74%
{Shenshu (BL23)}	{Weizhong (BL40)}	321	41.91%	77.16%
{Huantiao (GB30)}	{Weizhong (BL40)}	317	41.38%	71.88%
{Yanglingquan (GB34)}	{Huantiao (GB30)}	292	38.12%	88.22%
{Jiaji (EX-B2)}	{Huantiao (GB30)}	260	33.94%	63.88%
{Dachangshu (BL25)}	{Huantiao (GB30)}	260	33.94%	60.05%
{Dachangshu, Shenshu}	{Weizhong (BL40)}	256	33.42%	77.58%
{Kunlun (BL60)}	{Weizhong (BL40)}	208	27.15%	93.69%
{Ashi point(s)}	{Weizhong (BL40)}	206	26.89%	79.23%
{Huantiao, Shenshu}	{Weizhong (BL40)}	201	26.24%	81.38%
{Dachangshu, Huantiao}	{Weizhong (BL40)}	197	25.72%	75.77%
{Huantiao, Jiaji}	{Weizhong (BL40)}	190	24.80%	73.08%
{Huantiao, Shenshu}	{Dachangshu}	186	24.28%	75.30%
{Ashi point(s)}	{Shenshu (BL23)}	184	24.02%	70.77%
{Jiaji, Yanglingquan}	{Huantiao (GB30)}	177	23.11%	90.31%
{Ashi point(s)}	{Dachangshu (BL25)}	173	22.58%	66.54%
{Chengshan (BL57)}	{Weizhong (BL40)}	171	22.32%	90.96%
{Zhibian (BL54)}	{Weizhong (BL40)}	171	22.32%	87.24%
{Dachangshu, Yanglingquan}	{Huantiao (GB30)}	166	21.67%	90.71%
{Shenshu, Yanglingquan}	{Huantiao (GB30)}	157	20.50%	88.70%
{Yaoyangguan (DU3)}	{Shenshu (BL23)}	155	20.23%	75.61%
{Xuanzhong (GB39)}	{Yanglingquan (GB34)}	151	19.71%	91.52%
{Ashi point(s), Shenshu}	{Weizhong (BL40)}	151	19.71%	82.07%

The network analysis visualization revealed Weizhong (BL40), Yanglingquan (GB34), and Dachangshu (BL25) as central nodes with high connectivity, while Xuanzhong (GB39) demonstrated exceptional lift values, indicating synergistic effects when combined with other points. The association matrix highlighted stable relationships between Yaoyangguan (DU3) and Guanyuanshu (BL26), as well as between Yanglingquan (GB34) and Fengshi (GB31), suggesting systematic treatment approaches (Table 5, Figures 3–4, [Supplementary Figures 1](#) and [2](#)).

Hierarchical Cluster Analysis

Cluster analysis of high-frequency acupoints (usage ≥ 10) using Ward's linkage method identified six distinct clusters at a relative distance threshold of 23.5, representing different therapeutic strategies:

Cluster 1 (Constitutional strengthening): Guanyuan (RN4), Qihai (RN6), Shuifen (RN9) - These Conception Vessel points focus on tonifying kidney yang and strengthening constitutional energy.

Cluster 2 (Gallbladder meridian strategy): Yangfu (GB38), Xiyangguan (GB33), Zulinqi (GB41), Huantiao (GB30), Yanglingquan (GB34), Xuanzhong (GB39), Fengshi (GB31), Qiuxu (GB40) - This cluster represents a comprehensive Gallbladder meridian approach targeting lateral leg symptoms and hip dysfunction.

Cluster 3 (Posterior leg and paravertebral approach): Feiyang (BL58), Fuyang (BL59), Jiaji (EX-B2) - These points address posterior leg symptoms and utilize paravertebral segmental innervation.

Cluster 4 (Anterior leg and liver regulation): Futu (ST32), Biguan (ST31), Zusanli (ST36), Taichong (LR3), Xuehai (SP10) - This cluster combines anterior thigh points with liver qi regulation for comprehensive lower extremity treatment.

Cluster 5 (Core Bladder meridian and Back-Shu strategy): Guanyuanshu (BL26), Qihai Shu (BL24), Xiaochangshu (BL27), Kunlun (BL60), Chengshan (BL57), Zhibian (BL54), Yinmen (BL37), Weizhong (BL40), Chengfu (BL36),

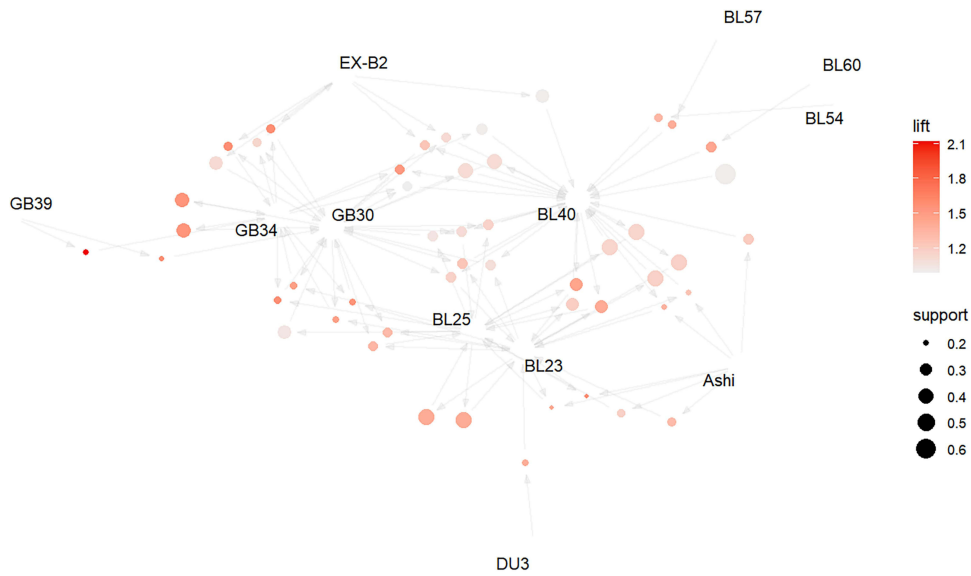


Figure 3 Network diagram of acupoint association rules. The graph illustrates the relationships between frequently co-occurring acupoints. Nodes represent individual acupoints, and edges represent the strength of the association rules between them.

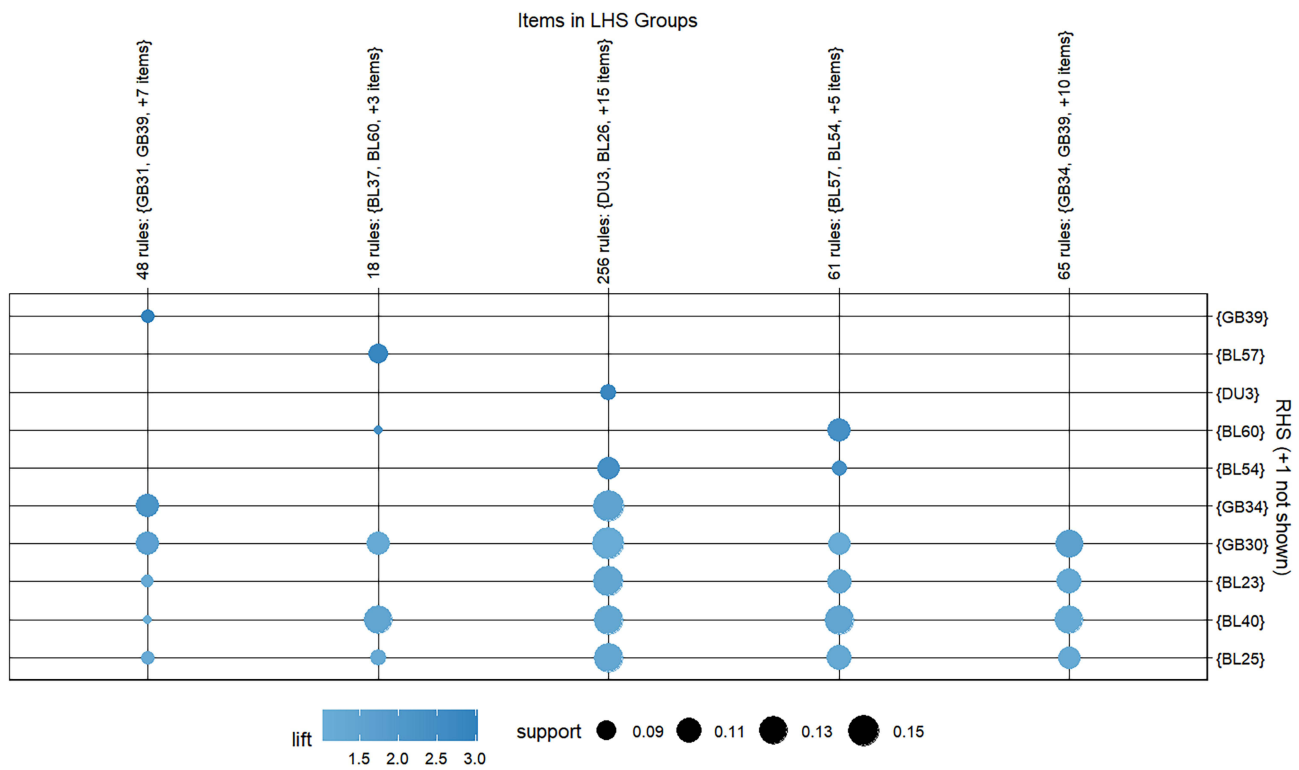


Figure 4 Association matrix heatmap. The heatmap visualizes the Support and Lift values for various acupoint combinations. Color intensity indicates the strength of the correlation, highlighting core acupoint pairs used in clinical practice.

Dachangshu (BL25), Shenshu (BL23), Ashi points, Geshu (BL17) - This represents the most comprehensive cluster, utilizing the complete Bladder meridian approach with organ-specific Back-Shu points.

Cluster 6 (Governor Vessel and kidney strengthening): Jizhong (DU6), Yaoyu (DU2), Yaoyan (EX-B6), Ciliao (BL32), Shangliao (BL31), Weiyang (BL39), Houxi (SI3), Sanyinjiao (SP6), Yaoyangguan (DU3), Mingmen (DU4),

Shiqizhui (EX-B7), Taixi (KI3) - This cluster emphasizes spinal governance and kidney function strengthening through Governor Vessel and kidney meridian integration.

The dendrogram analysis revealed logical groupings that correspond to traditional Chinese medicine theory while demonstrating data-driven clinical applications. The largest cluster (Cluster 5) encompasses the most frequently used points, suggesting a core treatment protocol, while smaller clusters represent specialized approaches for specific symptom patterns or constitutional types (Figure 5).

Discussion

This study represents the first comprehensive data mining analysis of acupoint selection patterns in the treatment of lumbar disc herniation (LDH), revealing several significant findings. Most notably, our analysis identified 13 core acupoints that accounted for 74.65% of total usage (5219 occurrences), demonstrating clear consensus in clinical practice. The dominance of the Bladder meridian, contributing 57.68% of total frequency with 42 distinct acupoints, highlights its central role in LDH treatment. Analysis of the high-frequency acupoints showed that Weizhong (BL40, 9.68%), Huantiao (GB30, 8.47%), and Dachangshu (BL25, 8.30%) were the most commonly selected points, suggesting their particular clinical significance in LDH management. The association rule analysis identified 449 core rules, with key combinations such as Weizhong (BL40)-Dachangshu (BL25) showing high support (42.43%) and confidence values, indicating stable and reliable treatment patterns. These findings provide the first quantitative evidence base for acupoint selection in LDH treatment, moving beyond traditional empirical approaches to establish data-driven protocols. Furthermore, the neural distribution analysis revealed a logical pattern of acupoint selection corresponding to relevant nerve pathways, with lumbar nerves (25.72%), sciatic nerve complex (22.55%), and posterior femoral cutaneous nerve (9.54%) being predominantly involved, suggesting a neuroanatomically-informed approach to point selection.

The predominance of Weizhong (BL40) as the most frequently used acupoint (9.68%) aligns with both classical theory and modern research. Located on the Bladder meridian of foot Taiyang, Weizhong represents a convergence point for qi and blood, with anatomical studies confirming its relationship to the posterior femoral cutaneous nerve and tibial nerve pathway.²² Clinical research has demonstrated its efficacy in improving sciatic nerve function and nerve conduction parameters.²³ Neuroimaging studies using functional magnetic resonance imaging (fMRI) have shown that acupuncture at Weizhong activates specific brain regions associated with chronic low back pain,^{24,25} suggesting a neurological basis for its therapeutic effects. The second most frequently used point, Huantiao (GB30, 8.47%), has historical significance in LDH treatment,²⁶ with classical texts emphasizing its role in treating lumbar pain and lower limb dysfunction.²⁷

The dominance of the Bladder meridian (57.68%) followed by the Gallbladder meridian (26.05%) reflects the classical principle that “Where the meridian passes, the disorder can be treated”. The Bladder meridian’s pathway, as described in classical texts, closely parallels the sciatic nerve distribution, explaining its effectiveness in treating posterior leg symptoms. Modern studies have shown that needling Bladder meridian points near lumbosacral nerve roots can inhibit inflammatory mediators and reduce nerve root edema.^{28,29} The minimal usage of hand meridians (each <1%) suggests a focused approach targeting the primarily affected channels.

The analysis revealed significant correlations among key point combinations, particularly Weizhong (BL40)-Dachangshu (BL25) (support 42.43%). This combination exemplifies the traditional principle of “He-Sea treatment for internal organs” while representing a distal-proximal pairing strategy. The high confidence values (>90%) for several combinations suggest reliable clinical protocols. These patterns align with modern understanding of neural pathway activation and pain modulation.^{30,31}

The six identified clusters represent distinct therapeutic strategies grounded in TCM theory. Cluster 1 (Constitutional strengthening) focuses on Conception Vessel points for tonifying kidney yang and strengthening constitutional energy, reflecting the traditional understanding of LDH as often involving kidney deficiency.³² Cluster 2 (Gallbladder meridian strategy) demonstrates a comprehensive approach to lateral leg symptoms through points like Yanglingquan (GB34) and Xuanzhong (GB39), with modern studies showing their effectiveness in improving nerve conduction.³² The core Bladder meridian cluster (Cluster 5) exhibited the highest clinical significance, incorporating key Back-Shu points that modern research has shown to modulate inflammatory mediators and improve local circulation.³³ These acupoint clusters embody

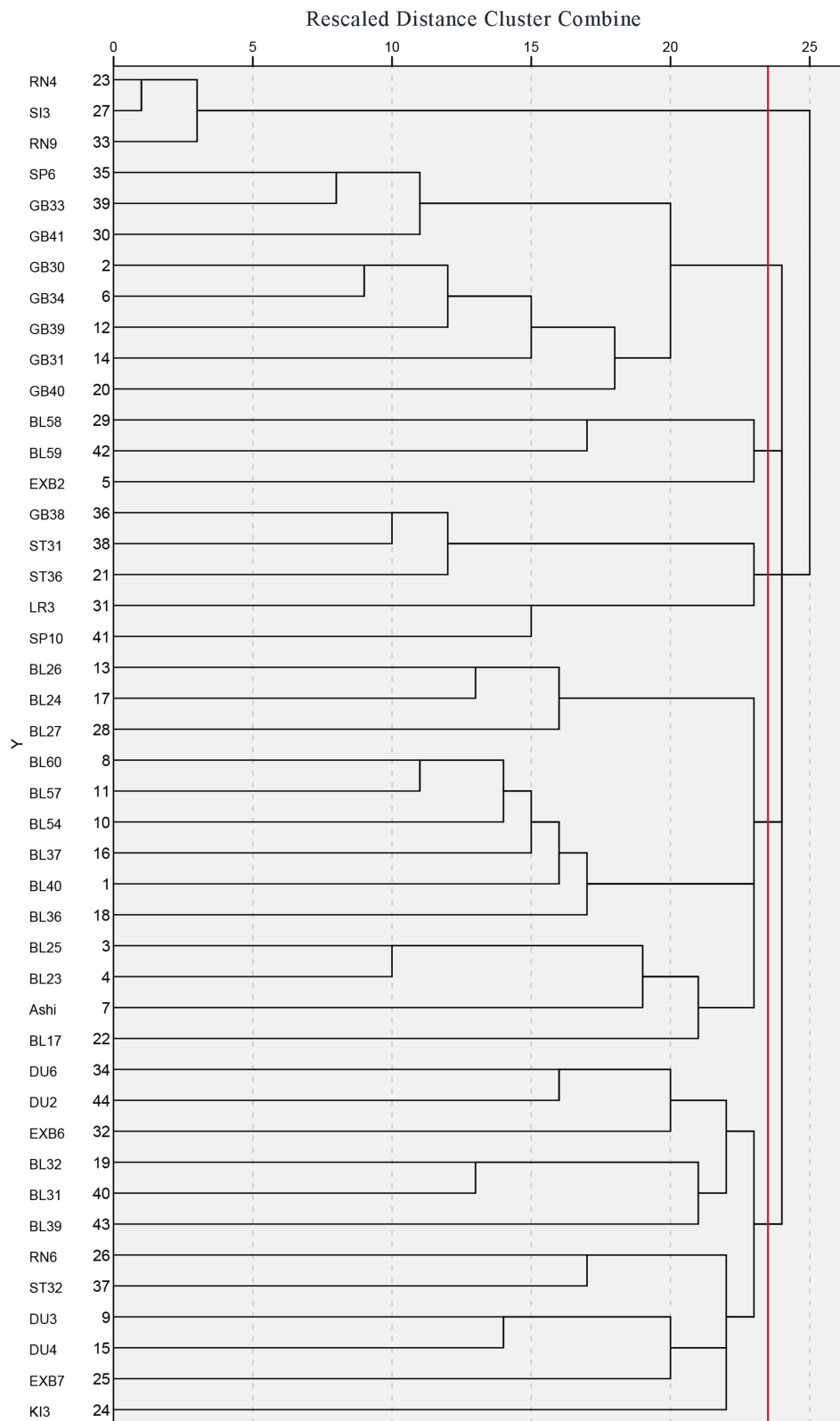


Figure 5 Dendrogram of hierarchical cluster analysis. The clustering analysis includes high-frequency acupoints (usage frequency > 10). The dendrogram classifies these acupoints into six distinct clusters, representing different therapeutic strategies.

both the time-honored theoretical heritage of TCM and modern scientific validation, showcasing their holistic therapeutic efficacy.³²

The predominant involvement of lumbar nerves (25.72%) in acupoint distribution directly corresponds to the pathophysiology of LDH. This pattern aligns with modern neuroanatomical understanding, as these nerves govern motor and sensory functions in the affected regions.³⁴ The significant representation of the sciatic nerve complex (22.55%) reflects the common L4-L5 and L5-S1 compression patterns in LDH.³⁴ Research has shown that acupuncture at points corresponding to these neural pathways can improve the microenvironment of compressed nerves through anti-inflammatory effects and enhanced microcirculation.³⁵

Our findings support a data-driven approach to acupoint selection in LDH treatment. The identified core combinations, particularly those centered around Weizhong (BL40) and Dachangshu (BL25), provide a foundation for standardized protocols. The clear pattern of neural correspondence suggests that practitioners should consider both traditional meridian theory and neuroanatomical relationships when selecting points. Recent clinical trials have validated this integrated approach, showing improved outcomes when treatment protocols incorporate both classical theory and modern neurological understanding.^{34,36}

Several limitations should be considered when interpreting our findings. First, the heterogeneity of included studies in terms of methodological quality and reporting standards may affect the reliability of frequency analyses. Second, the inability to account for treatment parameters such as needle manipulation techniques, retention time, and treatment frequency limits our understanding of optimal stimulation protocols.³⁷ Third, while our data mining approach revealed clear patterns, it cannot definitively establish causality between specific point combinations and clinical outcomes. Fourth, the exclusion of certain study types and potential publication bias may have influenced our results. Finally, due to the large volume of included studies (n=537) and the study's focus on data mining of prescription patterns rather than efficacy evaluation, we did not conduct a systematic assessment of methodological quality (eg, risk of bias). This may limit the interpretation of the evidence level, and future studies with focused meta-analyses are needed.

Future research should focus on validating the effectiveness of the identified core point combinations through well-designed randomized controlled trials. Studies investigating the neurophysiological mechanisms underlying the observed patterns of neural distribution are needed.³⁸ The role of different cluster-based approaches in treating various LDH subtypes warrants investigation. Additionally, research comparing the effectiveness of traditional point combinations with modern neuroanatomically-based selections could provide valuable insights into optimal treatment strategies.⁸ It is important to note that high frequency of acupoint usage reflects clinical consensus and common practice patterns derived from effective cases, but does not equate to direct evidence of superior efficacy. These core combinations should be viewed as optimized candidate protocols that require validation in future high-quality RCTs.

This comprehensive data mining analysis has revealed clear patterns in acupoint selection for LDH treatment, bridging traditional Chinese medicine theory with modern neuroanatomical understanding. The identification of core point combinations, meridian preferences, and neural distribution patterns provides a data-driven foundation for standardizing acupuncture protocols. The strong correspondence between traditional point selection and modern neuroanatomical knowledge suggests that ancient empirical observations align with contemporary scientific understanding. These findings have significant implications for both clinical practice and future research in the field of acupuncture for LDH treatment.

Conclusion

This data mining analysis indicates that acupuncture treatment for lumbar disc herniation follows a core prescription pattern dominated by the Bladder meridian and specific acupoints such as Weizhong and Huantiao. The identified therapeutic strategies integrate local and distal point selection, targeting key neural segments including the lumbar and sciatic nerves, while addressing both the root (tonifying kidney/spleen) and manifestation (activating blood/removing stasis) of the disease. These findings offer a data-driven reference for clinical standardization; however, given the study's reliance on literature mining, these patterns necessitate further validation through rigorous clinical trials.

Abbreviations

BL, Bladder meridian; CNKI, China National Knowledge Infrastructure; CT, Computed Tomography; DU, Governor Vessel (Du Mai); EX-B, Extra Point of Back; EX-HN, Extra Point of Head and Neck; EX-UE, Extra Point of Upper Extremity; fMRI, functional Magnetic Resonance Imaging; GB, Gallbladder meridian; HT, Heart meridian; KI, Kidney meridian; LDH, Lumbar Disc Herniation; LI, Large Intestine meridian; LR, Liver meridian; MRI, Magnetic Resonance Imaging; PC, Pericardium meridian; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT, Randomized Controlled Trial; RN, Conception Vessel (Ren Mai); SI, Small Intestine meridian; SJ, Triple Energizer meridian (Sanjiao); SP, Spleen meridian; ST, Stomach meridian; STRICTA, Standards for Reporting Interventions in Clinical Trials of Acupuncture; TCM, Traditional Chinese Medicine; VIP, Chongqing VIP Database; WHO, World Health Organization.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article and [Supplementary materials](#).

Ethical Considerations

As this study involved analysis of previously published literature and did not include primary data collection from human subjects, ethical approval was not required. However, all data extraction and analysis procedures were conducted in accordance with established guidelines for data mining studies.

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Author Contributions

Zehao Zheng and Juanjuan Feng contributed equally to this work, including the conception and design of the study, data acquisition, and data analysis and interpretation, and they drafted and revised the manuscript. Yang Li, Xiaonan Li and Chenyang Su contributed to the literature search, data extraction and statistical analysis, and assisted in drafting and revising the manuscript. Peng Bai conceived and supervised the study and critically revised the manuscript. All authors made substantial contributions to this work, approved the final version for publication, agreed on its submission to the *Journal of Pain Research*, and agreed to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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