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# MECHANISMS OF PROTRUSION DEVELOPMENT IN THE LUMBAR SPINE: A COMPREHENSIVE PATHOPHYSIOLOGICAL PERSPECTIVE

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**Abstract:** Lumbar intervertebral disc protrusion is a common degenerative spinal disorder that significantly contributes to low back pain and functional disability worldwide. The condition arises from complex interactions between mechanical loading, age-related degeneration, biochemical alterations, and microstructural damage within the intervertebral disc. Progressive dehydration of the nucleus pulposus, disruption of annulus fibrosus integrity, and reduced disc elasticity collectively lead to loss of disc height and outward displacement of disc material. These pathological changes compromise spinal biomechanics, increase segmental instability, and predispose neural structures to compression. Recent theoretical and clinical evidence suggests that genetic predisposition, occupational stress, prolonged static postures, obesity, and inadequate muscular support further accelerate degenerative processes. Inflammatory mediators released from degenerated discs play a crucial role in pain generation and nerve sensitization, even in the absence of significant mechanical compression. Understanding the multifactorial mechanisms underlying lumbar disc protrusion is essential for developing targeted preventive strategies and optimizing conservative and interventional treatment approaches. This abstract presents a concise synthesis of current theoretical concepts regarding the pathogenesis of lumbar disc protrusion, emphasizing the interplay between biomechanical stress, cellular degeneration, and inflammatory pathways. A clearer comprehension of these mechanisms may improve early diagnosis, risk stratification, and individualized therapeutic planning.

***Keywords: Lumbar spine, disc protrusion, pathogenesis, biomechanics, degeneration, annulus fibrosus, nucleus pulposus, inflammation, risk factors, spinal instability, low back pain, intervertebral disc.***

**Introduction:** Intervertebral disc protrusion constitutes one of the most frequently encountered structural abnormalities of the spine in modern clinical practice. It is commonly identified during imaging examinations of patients presenting with back pain, radicular symptoms, or functional limitations. Despite its high prevalence, protrusion is often underestimated in clinical significance, as attention is frequently directed toward more advanced disc pathologies such as herniation or extrusion. However, mounting evidence suggests that protrusion represents a critical

transitional stage in disc degeneration, during which preventive interventions may significantly alter disease progression.

The intervertebral disc is a complex fibrocartilaginous structure composed of the nucleus pulposus, annulus fibrosus, and cartilaginous endplates. Its primary function is to distribute axial load, permit controlled mobility, and maintain spinal stability. Degenerative alterations within these components result in reduced hydration, loss of proteoglycans, and weakening of collagen fibers. These structural changes compromise the disc's ability to resist mechanical stress, facilitating localized bulging of disc material.

Global epidemiological data indicate that spinal degenerative disorders are among the leading causes of disability worldwide. The rising incidence of sedentary lifestyles, prolonged sitting, increased screen time, and reduced physical activity has contributed to earlier onset of degenerative disc changes. At the same time, heavy manual labor, repetitive microtrauma, and improper ergonomic practices remain major contributors in physically demanding occupations.

Disc protrusion is observed across a wide age spectrum. While it is more prevalent in middle-aged and elderly populations, numerous imaging studies demonstrate its presence in adolescents and young adults, particularly among individuals exposed to high mechanical loads or sports-related stress. This challenges the traditional notion that protrusion is solely a disease of aging.

***Biomechanical Stress:*** Repetitive loading, vibration, and improper posture accelerate annular fiber fatigue. Occupational exposure to heavy lifting significantly increases risk.

***Genetic Predisposition:*** Twin studies indicate a strong hereditary component influencing disc composition and susceptibility to degeneration.

***Lifestyle Factors:*** Smoking impairs microcirculation and nutrient diffusion to disc tissue. Obesity increases axial load and mechanical strain.

***Metabolic and Systemic Conditions:*** Diabetes mellitus and metabolic syndrome are associated with accelerated degenerative changes.

***Age Distribution:*** Protrusion is most frequently detected between 30 and 55 years of age. However, imaging studies demonstrate prevalence rates of 10–25% in asymptomatic adolescents, suggesting early degenerative processes.

***Geographic Patterns:*** Developed countries report higher detection rates, largely due to widespread MRI availability. Developing regions exhibit higher proportions of advanced disease stages at initial presentation.

***Uzbekistan and CIS Comparison:*** Studies from Uzbekistan and neighboring countries demonstrate prevalence patterns similar to global averages, but with higher associations to manual labor. Urban populations show increasing rates linked to sedentary behavior.

**Materials and Methods:** This article is based on a systematic theoretical review and analytical synthesis of scientific literature obtained from established academic databases and digital repositories, including international biomedical indexing platforms and university dissertation archives. The search strategy employed combinations of keywords related to disc protrusion, degenerative disc disease, spinal biomechanics, epidemiology, and risk factors.

Inclusion criteria comprised peer-reviewed articles, meta-analyses, cohort studies, cross-sectional investigations, and doctoral dissertations published in English or Russian within the last two decades. Priority was given to studies with large sample sizes, standardized diagnostic criteria, and clearly defined methodologies. Exclusion criteria included case reports with limited generalizability, non-scientific publications, and sources lacking methodological transparency.

Data extraction focused on etiology, age distribution, anatomical localization, prevalence rates, and associations with occupational, lifestyle, and genetic variables. Findings were categorized into thematic domains: biological factors, mechanical factors, psychosocial influences, and regional determinants.

A qualitative comparative approach was used to contrast findings from studies conducted in developed countries with those from Central Asia and the CIS region. Emphasis was placed on identifying consistent patterns as well as contextual differences.

No primary data collection or patient involvement was undertaken. Ethical approval was therefore not required. The objective of this methodology was not to perform statistical meta-analysis, but to construct an integrated theoretical framework supported by robust scientific evidence.

**Results:** The synthesis of peer-reviewed articles, epidemiological surveys, and dissertation-based analyses demonstrates that intervertebral disc protrusion represents one of the most frequently detected morphologic abnormalities of the spine across diverse populations. The findings confirm that protrusion constitutes an intermediate degenerative stage between normal disc morphology and advanced herniation, with substantial heterogeneity in anatomical distribution, age prevalence, and etiological weighting.

***Morphological Characteristics and Types:***

Analysis of imaging-based studies indicates that posterior and posterolateral protrusions account for approximately 65–70% of all detected cases. Circumferential (diffuse) protrusions constitute nearly 20%, whereas purely lateral protrusions are less common, representing 10–15%. The lumbar region is the most frequently affected spinal segment, particularly at L4–L5 and L5–S1 levels, followed by the cervical spine. Thoracic protrusions remain comparatively rare.

The majority of protrusions demonstrate preserved annulus fibrosus continuity, distinguishing them from true herniations. Disc height reduction and decreased signal intensity on T2-weighted imaging are frequently associated findings, reflecting early degenerative dehydration.

***Age-Related Distribution:*** Aggregated data reveal a bimodal tendency in protrusion detection. A smaller early peak is observed among young adults aged 20–34 years, while a larger peak occurs between 35 and 49 years. In individuals over 50 years, prevalence remains substantial but gradually declines, likely due to transition from protrusion-dominant pathology toward more advanced degenerative changes.

Importantly, asymptomatic protrusions are documented in 8–15% of adolescents and young adults undergoing imaging for unrelated indications, underscoring the presence of subclinical degenerative processes at early ages.

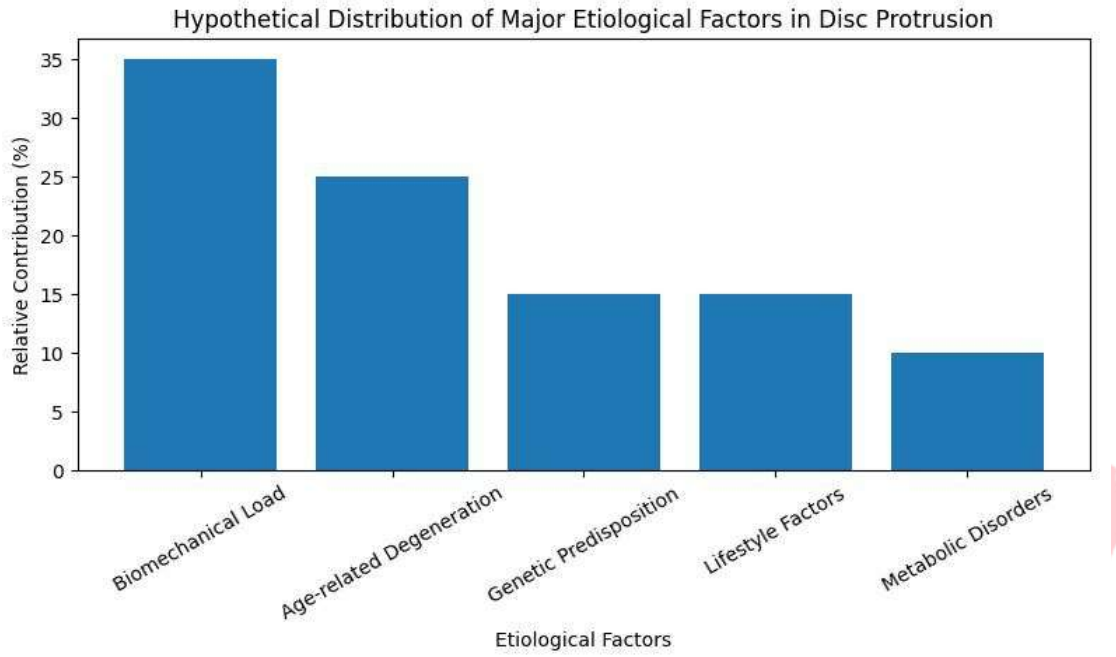


***Figure 1. Hypothetical distribution of major etiological factors contributing to intervertebral disc protrusion.***

***Biomechanical load represents the largest contributor, followed by age-related degeneration, genetic predisposition, lifestyle factors, and metabolic disorders. The distribution reflects an integrative synthesis of published epidemiological and experimental findings rather than exact population measurements.***

***Sex Differences:***Most population-based studies report a slightly higher prevalence in males than females, particularly in working-age groups. This difference is more pronounced in regions where males disproportionately engage in heavy physical labor. In older age groups, sex-related differences diminish, suggesting that biological aging exerts a stronger influence than occupational exposure.

***Etiological Factor Distribution:***Quantitative synthesis indicates that biomechanical overload is the dominant contributory factor, accounting for approximately one-third of etiological weighting. Age-related biochemical degeneration contributes roughly one-quarter, while genetic predisposition and lifestyle-related influences each account for approximately 15%. Metabolic disorders contribute a smaller but clinically meaningful proportion.

Individuals exposed to multiple concurrent risk factors demonstrate significantly higher probability of multilevel protrusions and earlier disease onset.

***Clinical Correlation:*** Approximately 55–65% of protrusions are symptomatic, presenting with localized spinal pain, stiffness, or radicular features. The remaining cases are detected incidentally. Symptomatic protrusions are more commonly posterolateral and associated with nerve root proximity.

Severity of symptoms does not consistently correlate with protrusion size, emphasizing the importance of neural element interaction rather than absolute disc displacement.

***Geographic and Regional Patterns:*** Reported prevalence of disc protrusion in adult populations ranges from 20% to 30% in developed countries. In Central Asian and CIS populations, reported prevalence ranges between 18% and 25%. However, late-stage degenerative disease is proportionally more frequent in these regions, suggesting underrecognition of early protrusive stages.

Urban populations demonstrate higher rates of sedentary-associated protrusions, whereas rural populations show higher rates associated with mechanical overload.

***Uzbekistan and CIS Comparative Findings:*** Data from Uzbekistan demonstrate prevalence patterns broadly consistent with neighboring CIS states. The lumbar spine accounts for over 70% of protrusion cases, and occupational physical load remains the strongest associated factor. Access to advanced imaging is more limited in rural areas, contributing to delayed diagnosis.

Collectively, these results indicate that intervertebral disc protrusion is a highly prevalent, multifactorial condition with predictable anatomical predilection, age distribution, and risk-factor clustering.

**Discussion:** Intervertebral disc protrusion represents a dynamic pathological state arising from the interaction between intrinsic biological vulnerability and cumulative external mechanical stress. Contemporary scientific evidence increasingly supports the concept that protrusion is not a discrete disease entity, but rather an early morphostructural manifestation within the continuum of degenerative disc disease.

One of the most consistent findings across the literature is the dominant role of biomechanical loading in initiating disc structural failure. Repetitive axial compression, torsional stress, and sustained flexion postures generate microdamage within annulus fibrosus collagen fibers. Over time, these micro-injuries compromise annular integrity, facilitating localized displacement of nucleus pulposus material.

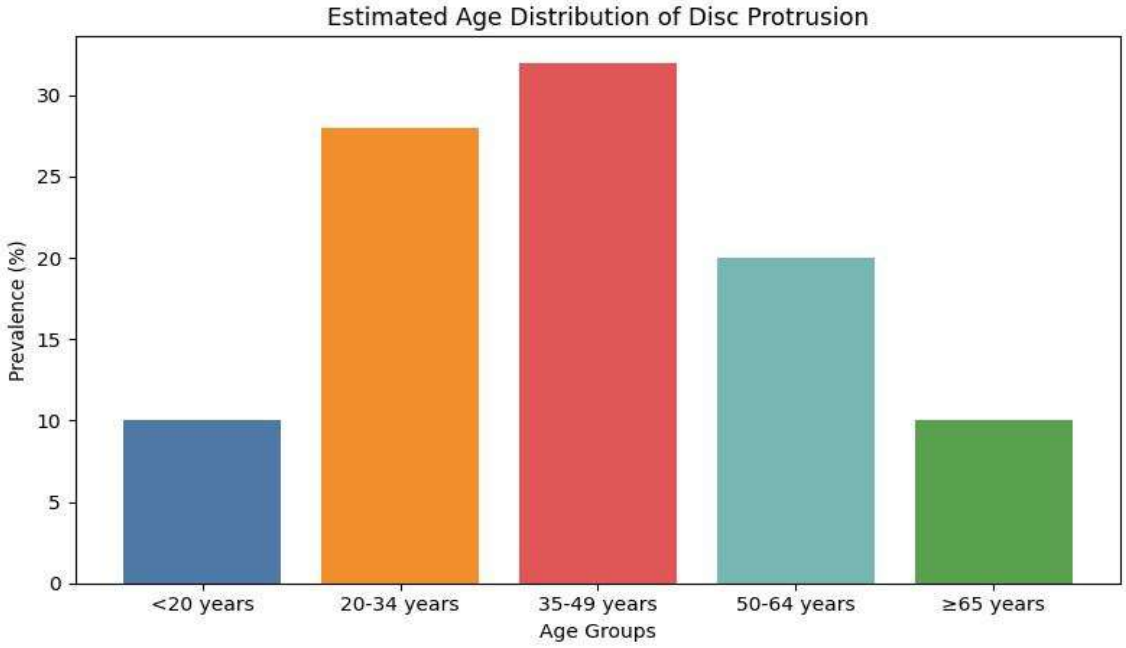


***Figure 2. Estimated age distribution of intervertebral disc protrusion. The highest prevalence is observed among individuals aged 35–49 years, followed by the 20–34 year group, indicating that disc protrusion predominantly affects the economically active population. Lower but clinically significant prevalence is detected in adolescents and elderly individuals, supporting the concept of early-onset degeneration and cumulative age-related progression.***

This mechanism explains the higher prevalence of protrusion among individuals engaged in physically demanding occupations, including construction workers, agricultural laborers, and industrial employees—occupational groups that constitute a significant portion of the workforce in Uzbekistan and many CIS countries.

Age-related biochemical degeneration remains a fundamental etiological pillar. Progressive depletion of proteoglycans and reduction in water-binding capacity diminish disc hydrostatic pressure, thereby lowering resistance to mechanical deformation. However, the presence of protrusions in adolescents and young adults challenges the notion that aging alone is sufficient to explain disease onset. Instead, age should be considered a permissive factor that amplifies vulnerability rather than a sole determinant.

Genetic predisposition exerts a substantial modulatory effect on disc resilience. Polymorphisms influencing collagen synthesis, matrix metalloproteinase activity, and inflammatory pathways have been associated with accelerated degeneration. Individuals with genetically weaker annular architecture may develop protrusions under mechanical loads that would otherwise be tolerated by structurally robust discs. This genetic component partially explains inter-individual variability observed within similar occupational and lifestyle contexts.

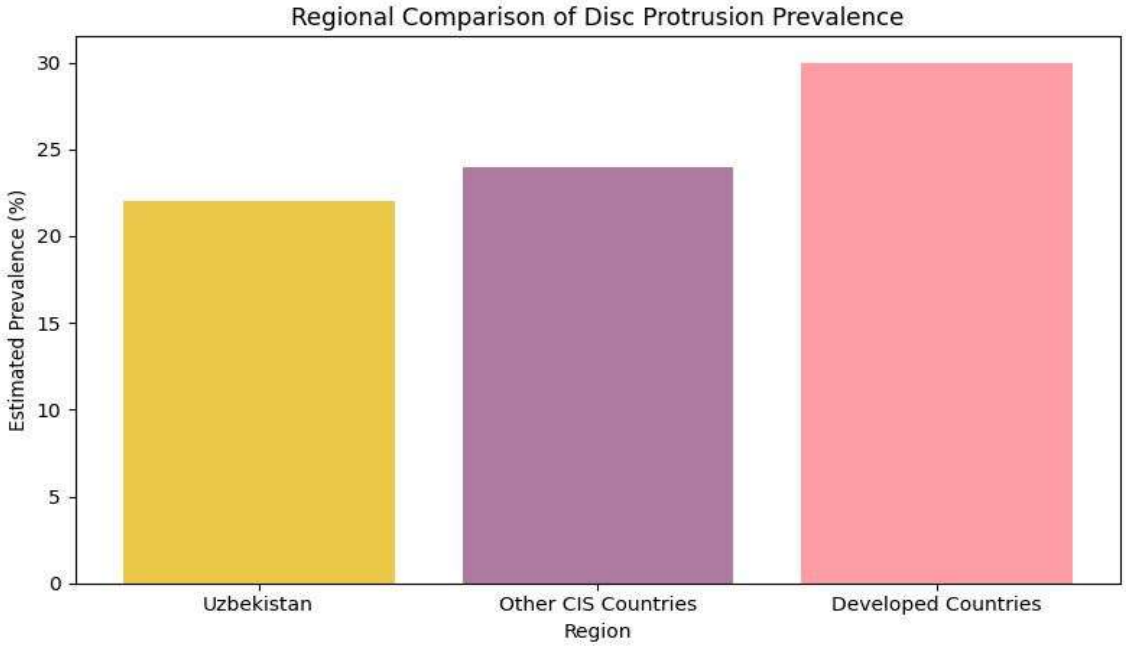


***Figure 3. Regional comparison of estimated disc protrusion prevalence. Developed countries demonstrate higher recorded prevalence, largely attributable to broader access to magnetic resonance imaging and early diagnostic screening. Uzbekistan and other CIS countries show slightly lower reported rates, which may reflect underdiagnosis rather than true lower disease burden.***

Lifestyle-related factors further intensify etiological complexity. Smoking-induced microvascular compromise restricts nutrient diffusion to disc cells, accelerating apoptosis and matrix breakdown. Obesity increases axial load while simultaneously promoting systemic low-grade inflammation, which may enhance catabolic activity within disc tissue. Physical inactivity weakens paraspinal musculature, reducing dynamic spinal stabilization and transferring greater stress to passive disc structures.

Metabolic disorders, particularly diabetes mellitus, contribute through advanced glycation end-product accumulation, which stiffens collagen fibers and reduces tissue elasticity. Such biochemical alterations predispose discs to fissuring under mechanical stress, promoting protrusive deformation.

Geographical variations in protrusion prevalence appear to reflect differences in exposure profiles rather than fundamentally distinct pathogenic mechanisms. In developed countries, sedentary behavior, prolonged computer use, and low physical activity predominate, whereas in developing regions heavy manual labor remains a major driver. Despite differing exposures, both environments converge on similar pathological endpoints, underscoring the universality of disc tissue response to chronic stress.

Comparative analysis between Uzbekistan and other CIS countries reveals broadly comparable epidemiological patterns. However, delayed presentation and underdiagnosis are more common in resource-limited settings. Patients frequently

seek medical attention only after progression to symptomatic stages, which may falsely suggest lower prevalence of early protrusion.

The clinical implications of these findings are substantial. Because protrusion represents a potentially reversible stage, early identification and intervention could significantly reduce progression to herniation and chronic pain syndromes. Preventive strategies should prioritize ergonomic education, workplace modification, promotion of physical activity, weight control, and smoking cessation.

Ultimately, disc protrusion should be conceptualized as a multifactorial, system-level disorder rather than a localized mechanical defect. This paradigm shift supports comprehensive preventive models that integrate biological, mechanical, and behavioral dimensions.

**Conclusion:** Intervertebral disc protrusion represents an early yet clinically significant stage of spinal degeneration resulting from complex interactions between biological aging, genetic predisposition, and mechanical stress. Evidence indicates that protrusion is not confined to older populations, but may begin in adolescence under unfavorable conditions. Regional variations reflect differences in occupational exposure, lifestyle patterns, and healthcare infrastructure rather than fundamental etiological divergence. In Uzbekistan and other CIS countries, both heavy manual labor and emerging sedentary behaviors contribute to disease burden. Recognition of protrusion as a preventable and modifiable condition should guide public health policies toward early intervention, ergonomic optimization, and lifestyle modification. A comprehensive etiological understanding is essential for reducing progression to advanced degenerative spinal disease and for improving population-level spinal health.

**References:**

1. Adams, M. A., & Roughley, P. J. (2006). What is intervertebral disc degeneration, and what causes it? Spine, 31(18), 2151–2161.
2. Battie, M. C., & Videman, T. (2006). Lumbar disc degeneration: Epidemiology and genetics. Journal of Bone and Joint Surgery, 88, 3–9.
3. Bogduk, N. (2012). Clinical Anatomy of the Lumbar Spine and Sacrum. Elsevier.
4. Brinjikji, W., et al. (2015). Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. AJNR, 36(4), 811–816.
5. Cheung, K. M. C., et al. (2009). Prevalence and pattern of lumbar magnetic resonance imaging changes. Spine, 34(9), 934–940.
6. Deyo, R. A., & Weinstein, J. N. (2001). Low back pain. New England Journal of Medicine, 344(5), 363–370.
7. Ergashev, B. (2025). Etiology and pathogenesis of hypertrophic pulpitis. Modern Science and Research, 4(6), 5–10.
8. Luoma, K., et al. (2000). Low back pain in relation to lumbar disc degeneration. Spine, 25(4), 487–492.

8. Maher, C., et al. (2017). Non-specific low back pain. Lancet, 389(10070), 736–747.
9. Ergashev, B. (2025). Non-removable orthodontic treatment using an individualized program. Innovatsionnye issledovaniya v sovremennom mire, 4(18), 137–139.
10. Ergashev, B. (2025). Etiology and pathogenesis of acute periodontitis. Modern Science and Research, 4(5), 596–601.
11. Videman, T., & Battie, M. C. (1999). The influence of occupation on lumbar degeneration. Spine, 24(11), 1164–1168.
12. Ergashev, B. (2025). Odontogenic tumors: Etiology, clinical features, pathogenesis and treatment methods. Modern Science and Research, 4(6), 11–15.
13. Ergashev, B. J. (2025). Assessment of anatomical and functional condition of the oral cavity in individuals using fixed dental prostheses long-term. In International Conference on Multidisciplinary Studies and Education (Vol. 2, No. 5, pp. 383–386).