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ORIGINAL ARTICLE

Trends and Characteristics of Preventive Spinal Health Screening: An Observational Analysis of 3000 individuals with ODI-based Functional Outcomes

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ABSTRACT

Spine-related disorders are among the leading global causes of disability, with increasing prevalence across all age groups due to sedentary lifestyles, poor posture, and age-related degeneration. There is a growing need for targeted interventions that address functional limitations through individualized care. This study evaluates the effectiveness of age-specific, personalized spinal interventions in a cohort of 3,000 patients treated at a dedicated spine health center. Functional outcomes were assessed using the Oswestry Disability Index (ODI), a validated tool for measuring spine-related disability. A total of 3,000 patients underwent comprehensive assessment and individualized treatment based on age, functional impairment, postural anomalies, and diagnostic imaging. Pre- and post-treatment ODI scores were compared across age groups (10–89 years). Data were analyzed for trends in baseline disability and improvement rates. The overall mean ODI score decreased from 24.53 to 15.35, representing a 37.4% improvement in functional status. The most notable improvement was seen in the 20–29 age group (48.4%), while the 80–89 group also exhibited a meaningful 31.0% improvement despite high baseline disability. A U-shaped pattern in baseline scores was observed, with higher disability in both younger (10–19) and older (80–89) cohorts. Age-stratified analysis revealed that tailored interventions yield substantial functional improvements across the lifespan. Younger patients respond more robustly, yet older adults also benefit significantly from structured rehabilitation. These findings advocate for individualized, age-sensitive treatment models and emphasize early intervention and functional goal alignment for improved outcomes in spinal health

Keywords: Spine health screening; Oswestry disability index ODI; Age specific rehabilitation; Personalized spine care; Functional outcomes; Postural and radiological assessment

1 INTRODUCTION

The global burden of spine-related disorders has reached epidemic proportions, with estimates suggesting that up to 80% of the population will experience significant back pain at some point in their lives. Spine disorders represent the leading cause of disability worldwide, affecting individuals across all age groups and significantly impacting quality of life, productivity, and healthcare expenditure [1,2].

According to studies, up to 23% of adults globally experience chronic low back pain, and between 24% and 80% of cases reoccur within a year. Adults experience up to 84% of their lifetime with back discomfort. Compared to adult patients, juvenile children experience lower rates of back discomfort. According to a Scandinavian study, the point prevalence of back discomfort was roughly 1% for children aged 12 and 5% for those aged 15. Fifty percent of girls and twenty percent of boys would have had at least one episode of

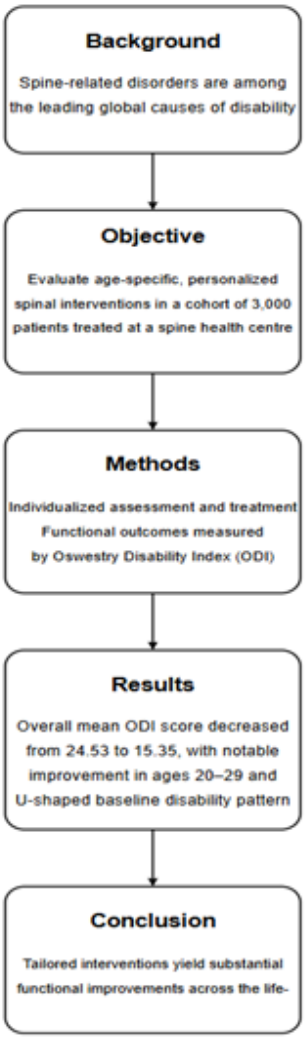


Fig. 1: Flow chart 1

back discomfort by the time they were eighteen. The lifetime prevalence of back pain in teenagers rises gradually with age, reaching adult proportions by the time they are 18 years old[3–5].

Spinal health concerns vary significantly across age groups. Adolescents frequently present with postural syndromes such as "text neck," growth-related imbalances, and early scoliosis, often influenced by prolonged screen use and sports. In young adults, poor ergonomics and sedentary habits contribute to early discogenic issues and minor herniations, which remain highly responsive to conservative treatment[3,6].

Early to peak middle age (30–49 years) marks the onset of degenerative disc disease, muscular deconditioning, and chronic myofascial pain, often triggered by occupational stress and physical strain. As individuals enter their 50s and 60s, spinal conditions such as lumbar spondylosis, spinal stenosis, and reduced tissue resilience become more pronounced, with slower but still significant recovery outcomes. In advanced age (70–89 years), degenerative and osteoporotic changes dominate, leading to conditions like kyphosis, multilevel disc degeneration, and compression fractures. However, across all age bands, the study findings indicate that functional rehabilitation remains effective, highlighting the value of age-specific, targeted interventions[7–9].

Recent epidemiological trends indicate a concerning rise in spine pathologies, attributable to multiple factors(prolonged sedentary behaviour, poor ergonomics, smart phone usage, decreased physical activity, rising obesity rates, poor posture habits, stress related muscle tension and sleep disruption) Increasingly sedentary lifestyles, with adults spending an average of 9.5 hours daily in seated positions and Widespread use of electronic devices creating postural strains ("text neck" phenomenon), Rising obesity rates placing additional stress on spinal structures. And aging populations experiencing age-related degenerative changes and some Occupational factors including repetitive movements and poor ergonomics[3,6,10].

These converging factors have created an unprecedented demand for effective spine care interventions. However, traditional "one-size-fits-all" approaches to spine health have demonstrated limited efficacy, highlighting the need for personalized treatment strategies that consider age-specific needs and functional goals[11,12].

Accurate assessment of disability due to low back pain (LBP) is essential for evaluating treatment outcomes and guiding clinical decision-making. The Oswestry Disability Index (ODI) is one of the most widely used and validated tools for measuring disability specifically related to spinal disorders. It demonstrates high reliability and internal consistency, with test-retest reliability coefficients typically exceeding 0.90, making it superior to many other disability questionnaires such as the Roland-Morris Disability Questionnaire (RMDQ) and Quebec Back Pain Disability Scale. Unlike other scales, the ODI offers greater specificity for chronic spinal conditions, capturing a broader range of functional impairments in daily activities. Its consistent use in both clinical and research settings has established it as a gold standard in spine-related disability measurement[13,14].

2 METHODOLOGY

2.1 Patient Assessment Protocol

Our comprehensive evaluation process for all 3,000 patients included:

Oswestry Disability Index (ODI): The Oswestry Disability Index (ODI), a patient- completed questionnaire, provides a subjective percentage score of function (disability) in activities of daily life. The questionnaire has 10 questions which consists of our day- today activities of daily living and each question contains of 6 statements which will be

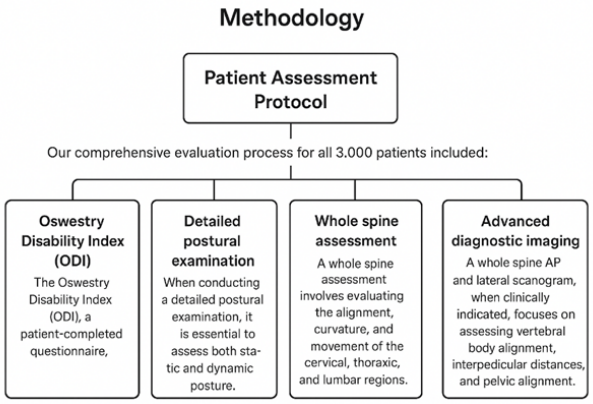


Fig. 2: Flow chart 2

scored from 0 to 5 based on the answers given by the patient and 0 indicates the least disability and 5 indicates maximum disability and overall score was calculated as a percentage and in that the 0% indicates no disability and 100% indicates the highest level of disability.

Detailed postural examination: When conducting a detailed posture examination, it is essential to assess both static and dynamic posture. Begin by observing the alignment of the head, neck deviation, both/bilateral shoulders, spine, pelvis, & position of both scapula ensuring they are symmetrically positioned. Note any deviations such as slouching, forward head posture, or uneven shoulder height & uneven PSIS position. Pay attention to the curvature of the spine (cervical, thoracic, and lumbar) and check for abnormal shifts in weight distribution. Evaluate muscle imbalances (like visible muscle wasting or muscle hypertrophies) and consider the impact of footwear or habitual movements and position of feet and more weight bearing limb. Lastly, observe posture during movement to detect any compensations or abnormalities in gait and flexibility.

Whole spine assessment: A whole spine assessment involves evaluating the alignment, curvature, and movement of the cervical, thoracic, and lumbar regions. Check for any visible deviations like scoliosis, kyphosis, or lordosis. Assess spinal flexibility by observing forward bending, side bending, and rotation. Palpate for tenderness, muscle tightness, or abnormalities in spinal structures. Finally, observe for any asymmetry in shoulder and pelvic height, which may indicate misalignment and range of motion testing, neurological screening, muscle strength evaluation, and specialized tests appropriate to the presenting condition.

Advanced diagnostic imaging: A whole spine AP and lateral scanogram, when clinically indicated, focuses on assessing vertebral body alignment, interpedicular distances, and pelvic alignment. In the AP view, we evaluate the symmetry of the vertebral column, noting any scoliosis or abnormal curvatures & pelvic rotations. In the lateral view, check for proper spinal curves, including cervical, thoracic, and lumbar lordosis. Ensure the sacrum is level, and vertebral bodies are well-aligned. Additionally, measure interpedicular distances to assess for any abnormalities. Pay attention to any anomalies, such as fractures, degenerative changes, or disc space reduction issues & foraminal narrowing.

Table 1: Treatment Approach: based on the Assessment and personalized treatment

TREATMENT APPROACH	
Comprehensive Assessment	**Tailored Treatment Program**
1. Age Specific Considerations	1. Identification of Root causes
2. Functional Limitations Through ODI	2. Manual therapy & Dry Needling
3. Postural Anomalies Requiring correction	3. Postural Re-education& Home Exercises
4. Specific Pathological Findings	4. Ergonomic modification to occupation
5. Patient Centred Functional Goals	5. Progressive Functional Rehabilitation

2.2 Data Collection and Analysis

Pre-treatment ODI scores were recorded at initial assessment, and post-treatment scores were documented following completion of the individualized treatment protocol. The data was stratified by age groups spanning from 10-19 years to 80-89 years. Statistical analysis included comparison of mean pre- and post-treatment scores, calculation of improvement percentages, and age-group comparisons.

3 RESULTS

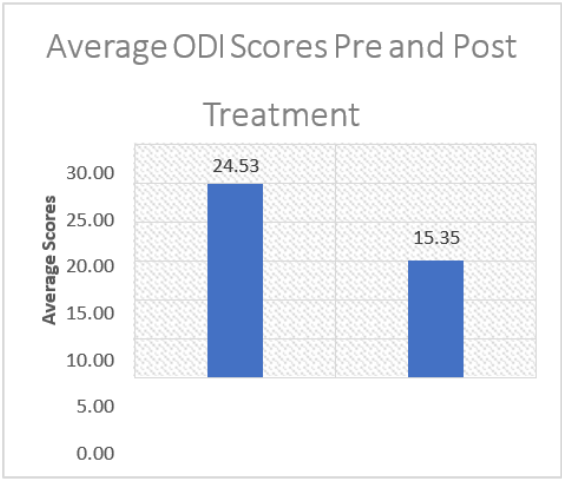


Fig. 3: Average ODI Scores

3.1 Overall Improvement Trends

Analysis of aggregate data across all age groups revealed

- **Mean pre-treatment ODI score**: 24.53
- **Mean post-treatment ODI score**: 15.35
- **Average improvement**: 37.4%

This substantial reduction in disability scores demonstrates the overall effectiveness of our tailored treatment approach.

3.2 Age-Specific Analysis

Examination of age-stratified data revealed notable patterns in both baseline impairment and treatment response: The pre-treatment and post-treatment ODI scores exhibit a clear age-related pattern, shedding light on the functional limitations and recovery outcomes across different age groups.

Pre-treatment baseline scores reveal a U-shaped distribution, with the highest disability observed in the 80-89 age group (29.00), followed closely by the 40-49 age group (26.73), and notably elevated scores in the 10-19 age group (25.25). This pattern suggests that both adolescents/young adults and middle-aged individuals experience significant functional limitations, though these limitations may arise from different underlying causes. In contrast, the 70-79 (22.14) and 60-69 (23.65) age groups showed the lowest pre-treatment disability, possibly reflecting a more resilient or adaptive physical status in these cohorts.

Post-treatment outcomes demonstrate improvements in ODI scores across all age groups, with the 20-29 age group showing the greatest relative improvement of 48.4%, dropping from 24.23 to 12.51. This suggests that younger adults may have a better response to treatment, possibly due to more robust recovery potential. The 30-39 age group also showed a substantial improvement (41.4%), moving from 24.59 to 14.42, further supporting the idea that middle- aged adults can experience significant functional recovery. The 80-89 age group, despite starting with the highest baseline disability, showed a moderate improvement of 31.0%, with scores decreasing from 29.00 to 20.00, indicating that even older adults experience meaningful benefits from treatment, though to a lesser extent. Lastly, the 70-79 age group had the smallest relative improvement of 14.2% (from 22.14 to 18.95), which may reflect the fact that older individuals have less capacity for recovery or face more complex, age-related challenges in treatment.

Overall, these findings highlight the importance of considering age-related factors when assessing treatment outcomes, as different age groups may exhibit varying levels of disability and recovery potential. The results emphasize the need for tailored treatment strategies that account for the unique functional challenges and recovery capabilities of individuals across the lifespan.

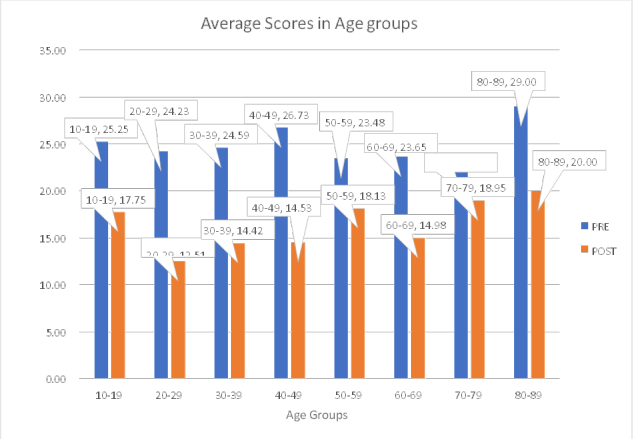


Fig. 4: Average Scores in Age Groups

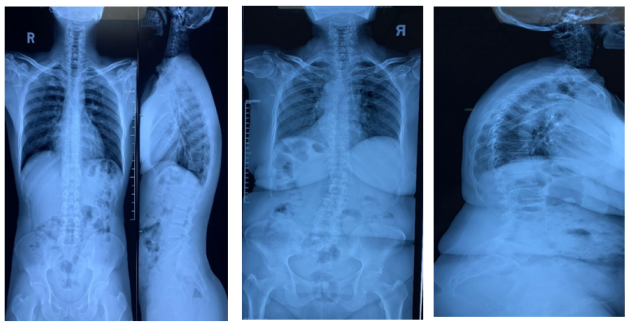
3.3 Age Group Insights

The data on the effectiveness of treatment across different age groups reveals varying levels of improvement in disability scores, shedding light on how age-related factors influence treatment outcomes. Adolescents and young adults (10-19) showed a 29.7% improvement, with high initial disability scores likely caused by postural strain from device usage, growth-related issues, and sports injuries. Young adults (20-29) experienced the highest improvement (48.4%), likely due to tissue resilience and strong treatment compliance. In early middle age (30-39), improvement was 41.4%, with significant gains despite work and family obligations that may impact treatment adherence. Peak middle age (40-49) individuals showed a 45.6% improvement, with the second highest initial disability scores, indicating peak spine stress during this life stage. Late middle age (50-59) had the lowest improvement (22.8%), possibly due to age-related decline in treatment responsiveness. Early older adults (60-69) demonstrated a better-than-expected response (36.7%), suggesting that age alone doesn't always dictate treatment outcomes. Older adults (70-79) showed the lowest relative improvement (14.2%), likely due to advanced degenerative changes, while those in advanced age (80-89) showed a remarkable 31.0% improvement despite the highest initial disability, emphasizing the potential for improvement with appropriate intervention. Overall, while younger individuals tend to show better treatment responses, older adults still benefit from targeted interventions, though their improvement is often more limited due to age-related factors.

3.4 Scanogram

An assessment of 3,000 young adults with lower and upper back pain to determine the root causes of their pain, identify which vertebral regions were contributing to spinal overloading, and understand the underlying mechanisms

of spinal stress. All participants who were in need for the scanogram had underwent comprehensive whole-spine analysis via scanogram, including anterior-posterior and lateral views. Based on the scanogram findings, we performed detailed radiological examinations that included measurement of cervical lordosis and thoracic kyphosis curvatures, analysis of rib mechanisms (bucket handle or pump handle movements), evaluation of rib-to-rib distance, assessment of rib cage positioning relative to the pelvis, and examination of pelvic alignment in relation to the cervical spine. For the lumbar spine and pelvis, we conducted several specific measurements: lumbar lordosis angles, vertebral body alignment to identify potential spondylolisthesis, interpedicular distance between lumbar vertebral bodies to assess lumbar vertebral rotation, which provides insight into right and left iliopsoas tightness, relationship between the 12th rib and ilium of the pelvis, crucial for evaluating quadratus lumborum dysfunction, pelvic incidence and hip rotations by measuring the distance from the greater trochanter to the acetabular rim. We correlated these radiological findings with clinical assessments, including muscle flexibility tests and spinal mobility evaluations, to establish comprehensive diagnostic profiles for each patient.



NORMAL-AP/LAT ABNORMAL-AP ABNORMAL-LATERAL

Fig. 5: Scanogram

Age Group	Initial Disability	Improvement	Treatment Focus	Mobility Phase	Stability Phase	Strengthening Phase	Training Phase
Adolescents (10-19)	High	29.70%	Postural Correction	Gentle spinal mobilization techniques, Dynamic stretching,Reduce device-related strain	Core stabilization exercises,Posture alignment drills,Balance work	Light resistance training,Body weight exercises,Injury prevention focus	Sport-specific mobility,Ergonomic education, Stress management
Young Adults (20-29)	Moderate	48.40%	Peak Performance	Active range of motion exercises,Spinal joint mobilization, Flexibility enhancement	Advanced core stabilization, Dynamic stability training,Proprioception development	Progressive resistance training,Functional strength circuits,Targeted muscle group work	Performance optimization, Work-life balance strategies, Preventive maintenance
Early Middle Age (30-39)	Moderate-High	41.40%	Work-Life Balance	Comprehensive spinal mobility,Stress-related tension release, Adaptive mobility techniques	Integrated core stability,Postural endurance training, Family-friendly exercises	Moderate resistance protocols,Time-efficient strength training,Muscle balance correction	Stress reduction techniques, Family-inclusive fitness, Workplace ergonomics
Peak Middle Age (40-49)	High	45.60%	Comprehensive Restoration	Advanced mobility interventions,Deep tissue mobilization, Flexibility restoration	Complex stability training, Compensatory movement correction,Joint protection strategies	Strength maintenance,Low-impact resistance training,Hormonal balance consideration	Holistic wellness approach, Injury prevention,Mental resilience training
Late Middle Age (50-59)	Moderate	22.80%	Gentle Restoration	Gentle spinal mobility,Soft tissue techniques,Pain-free movement patterns	Low-impact stability work,Joint health preservation,Progressive stability challenges	Moderate resistance,Joint-friendly strengthening,Sarcopenia prevention	Fall prevention,Functional independence,Lifestyle adaptation
Early Older Adults (60-69)	Moderate-Low	36.70%	Active Aging	Therapeutic mobility exercises,Range of motion preservation, Gentle joint mobilization	Adaptive stability training,Balance enhancement, Fall risk reduction	Supervised strength training,Light resistance protocols,Muscle mass maintenance	Social engagement,Cognitive-motor integration,Quality of life enhancement
Older Adults (70-79)	Low	14.20%	Supportive Care	Ultra-gentle mobility work,Passive range of motion,Pain management focus	Minimal resistance stability,Seated stability exercises,Assistive device integration	Very light resistance,Chair-based strengthening,Supervised exercises	Safety-first approach,Caregiver involvement,Confidence building
Advanced Age (80-89)	Very High	31.00%	Compassionate Intervention	Extremely gentle mobility,Therapist-assisted movements, Comfort-focused techniques	Minimal load stability,Supported exercise protocols,Safety-first approach	Micro-resistance training, Seated/Supported exercises,Individual capacity assessment	Personalized care,Family engagement,Dignified independence

4 DISCUSSION

Our results demonstrate several clinically significant trends:

Universal improvement across age cohorts: All age groups showed functional improvement following tailored treatment, challenging the notion that spine disorders in certain age groups (particularly older adults) are less responsive to intervention.

Peak responsiveness in younger adults: The most substantial improvements occurred in the 20-29 age group (48.4% reduction in disability scores), suggesting that early intervention may provide optimal outcomes.

Surprising resilience in the oldest cohort: Despite having the highest initial disability scores, the 80-89 age group demonstrated a 31.0% improvement, highlighting that advanced age should not preclude aggressive rehabilitation.

Critical middle-age vulnerability: The 40-49 age group presented with the second highest baseline disability scores, likely reflecting the cumulative effects of work- related stressors, decreased physical activity, and early degenerative changes.

Non-linear relationship between age and improvement: Rather than a steady decline in treatment response with advancing age, we observed fluctuations that suggest other factors (specific pathologies, comorbidities, lifestyle factors) may be more influential than chronological age alone.

Treatment Implications

These findings inform several clinical practice recommendations:

Age-specific treatment targeting: Recognizing the unique spinal challenges at different life stages allows for more precise intervention protocols.

Early intervention emphasis: The substantial improvements seen in younger cohort's support prioritizing early identification and treatment of spine disorders before chronic changes develop.

Optimism for geriatric outcomes: The meaningful improvements observed in older adults contradict therapeutic nihilism and support appropriate intervention regardless of advanced age.

Preventative focus for middle age: The peak disability scores in middle-aged groups highlight the need for preventative strategies targeting this vulnerable period.

Precision exercise prescription: The varying responses across age cohorts underscores the importance of age-appropriate exercise parameters, particularly regarding loading intensity, volume, and progression rates.

"Given the complex and multifactorial nature of spinal conditions, this study highlights the critical importance of considering age-specific physiological, biomechanical, and functional characteristics when developing treatment plans. The findings emphasize that tailored, personalized

interventions, rather than standardized approaches, are essential for achieving optimal outcomes across all age groups. Factors such as postural deviations, occupational.

stressors, lifestyle behaviors, and comorbidities should be integrated into assessment and treatment protocols to enhance efficacy. Furthermore, our results underscore the need for early intervention, particularly in younger populations, and the potential for significant functional improvements even in older adults with advanced degenerative changes.

Future research should focus on refining individualized treatment strategies that address these factors to maximize spine health outcomes and improve quality of life for patients across the lifespan."

Study Limitations

Several limitations should be considered when interpreting these results:

1. The absence of a control group limits definitive conclusions about treatment efficacy compared to natural history.
2. Multiple treatment components make it difficult to isolate which specific interventions were most effective for particular age groups.
3. The ODI, while validated, captures only certain aspects of spine-related disability and may not reflect all meaningful outcomes.
4. Potential confounding variables such as comorbidities, medication use, and psychosocial factors were not fully controlled for in this analysis.

5 CONCLUSION

This analysis of 3,000 patients demonstrates that age-appropriate, tailored spine care interventions produce significant functional improvements across the age spectrum. While treatment responsiveness varies among age cohorts, meaningful clinical improvements were achieved in all groups, including those of advanced age.

The distinctive patterns of baseline disability and treatment response revealed by our age- stratified analysis highlight the importance of age-specific approaches to spine care. Rather than applying standardized protocols, our findings support an individualized approach that considers the unique biomechanical, physiological, and functional characteristics associated with each life stage.

As the global burden of spine disorders continues to grow, these insights can guide more effective clinical decision-making and resource allocation. Future research should focus on identifying the most effective treatment components for specific age groups and determining optimal treatment parameters to maximize outcomes.

Our experience demonstrates that with appropriate assessment and personalized intervention, significant improvements in spine health are achievable regardless of age, offering hope to the millions worldwide affected by these debilitating conditions.

Further Research

Further research will analyse each component of the Oswestry Disability Index (ODI) across different age groups within our cohort of 3,000 individuals, potentially revealing age-specific patterns of functional disability that could inform more targeted treatment approaches.

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