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# From Bed to Back Relief: Evaluating a Biomechanical Mattress for Long-Term Pain and Functional Recovery

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## Introduction

Low Back Pain (LBP) is a widespread musculoskeletal condition affecting millions globally and is a leading cause of disability across all age groups. While numerous therapeutic interventions exist, non-pharmacological approaches, particularly those related to sleep ergonomics, have gained increasing attention. Among these, mattress design and selection are pivotal, as individuals spend nearly one-third of their lives in bed, making the sleep surface a significant environmental factor in spinal health. Clinical evidence suggests that the characteristics of a mattress, such as firmness, material composition, and pressure distribution, can significantly influence spinal alignment and, consequently, pain perception in individuals with chronic or acute LBP. For example, a study by Minetto et al. [1] conducted a pilot randomized controlled trial showing that an innovative mattress overlay improved rehabilitation outcomes in patients with LBP, emphasizing the potential of customized mattress systems in enhancing comfort and spinal alignment during rest. Similarly, Nawirska-Olszańska et al. [2] explored the use of buckwheat husks as a mattress material, reporting promising results in pressure relief and therapeutic benefit in LBP contexts. Moreover, a comprehensive literature review by Caggiari et al. [3] identified medium-firm mattresses as optimal for reducing LBP and enhancing sleep quality due to their balanced support and pressure redistribution properties. Other studies, such as that by Lacobson et al. [4], confirmed the beneficial impact of prescribed sleep surfaces on both pain intensity and sleep efficiency in individuals with chronic LBP, emphasizing the role of mattress ergonomics in multimodal pain management strategies. Among emerging non-invasive interventions, the MagniStretch® (Alessanderx, Prato, Italy) mattress presents a novel approach to managing low back pain through biomechanical traction during rest. Developed with sloped internal channels and high-resilience foam, the mattress is engineered to induce a gentle, passive stretching of the spinal column by harnessing the body's own weight distribution. This mechanism aims to decompress intervertebral discs and reduce muscular tension without active patient effort. The primary aim of this study was to evaluate the clinical effectiveness of the MagniStretch® mattress in reducing pain intensity, improving functional capacity, and enhancing sleep quality in patients with chronic low back pain. The study further aimed to assess whether age influences the degree of clinical response to mattress use over a 12-month follow-up period. We hypothesized that daily use of the MagniStretch® mattress would lead to statistically significant improvements in pain (as measured by the Visual Analog Scale), disability (assessed using the Oswestry Disability Index), and sleep quality (evaluated with the Pittsburgh Sleep Quality Index) after 12 months of use. It was further hypothesized that older patients (>50 years) would exhibit greater clinical benefit due to age-related spinal biomechanics and increased baseline symptom severity.

## Methods

This study enrolled patients affected by chronic low back pain, who underwent clinical evaluation between January 2023 and

December 2024. Each participant was instructed to use the investigational mattress, MagniStretch, daily for a follow-up period of twelve months in order to assess its clinical effectiveness in reducing lumbar pain and improving sleep quality. Eligible participants were aged between 20 and 75 years and were stratified into three age groups for analysis: Group 1 included patients aged 20 to 35 years; Group 2 included patients aged 36 to 50 years; and Group 3 included those older than 50 years. Inclusion criteria required a diagnosis of chronic, nonspecific low back pain lasting more than twelve weeks; a baseline pain score equal to or greater than 4 on the Visual Analog Scale (VAS); the ability to provide informed consent; and the absence of planned changes in pharmacologic or physical therapies during the first three months of follow-up. Exclusion criteria included radiologic evidence of severe spinal pathology, such as extruded disc herniation, vertebral fractures, spinal tumors, or infections; coexisting neurological or rheumatological disorders influencing pain perception; prior spinal surgery or planned interventions within the follow-up period; pregnancy or breastfeeding; and concurrent use of orthopedic sleep supports. Patients underwent clinical evaluation at baseline, at six months, and at twelve months using validated assessment tools. Pain intensity was quantified using the Visual Analog Scale (VAS), which provides a simple and reliable estimate of subjective pain levels [5]. Functional disability was assessed using the Oswestry Disability Index (ODI), considered a reference standard for evaluating the impact of low back pain on daily living [6]. Sleep quality was measured through the Pittsburgh Sleep Quality Index (PSQI), a validated instrument used to monitor sleep duration, disturbances, and efficiency over the preceding month [7]. These instruments were used to objectively evaluate the response to mattress use over the follow-up period.

### Magnistretch Mattress

The mechanical testing of the MagniStretch mattress was conducted to investigate its potential benefits in managing low back pain through its structural and ergonomic design. The testing was performed at the University of Saragossa using an INSTRON 8800 universal testing machine, which allows for precise control and measurement of applied loads and displacements. This test setup aimed to replicate the biomechanical conditions experienced by a human body during sleep. Two sections of the mattress were selected for analysis: one corresponding to the cervical spine area, which included a side opening, and another from the dorso-lumbar region without any side opening. Each specimen measured 550 mm by 380 mm by 220 mm and was composed of high-resilience polyurethane foam designed to accommodate varying pressures and distribute loads effectively across the mattress surface. To simulate the act of a person lying on the mattress, a custom apparatus comprising upper and lower tools was used. The upper tool functioned as a rocker to mimic both compression and longitudinal displacement, while the lower tool served as a support simulating a bed frame. During testing, a vertical compression force of up to 45 kiloponds was applied to each specimen. This load approximated the weight exerted by a person's cervical or dorso-lumbar region while resting. Measurements were collected using transducers integrated with the test machine. A load cell of 5 kN was positioned laterally to detect the longitudinal reaction force, and a position transducer monitored displacement across the test duration. The tests were conducted at two different speeds-60 mm/min and 120 mm/min-to evaluate dynamic responses under varying conditions.

### Statistical Analysis

Descriptive statistics were used to summarize demographic and clinical data. Continuous variables were expressed as mean ± Standard Deviation (SD), along with their respective ranges (minimum-maximum), and categorical variables were presented as frequencies and percentages. The normality of continuous variables was assessed using the Shapiro-Wilk test. Intra-group comparisons of clinical outcomes over time (baseline, 6 months, and 12 months) were performed using repeated measures analysis of variance (ANOVA) with post-hoc Bonferroni correction where appropriate. Inter-group differences between age categories (20-35, 36-50, >50 years) at each time point were analyzed using one-way ANOVA. When a significant main effect was observed, pairwise comparisons were conducted using Tukey's Honestly Significant Difference (HSD) test. A p-value $< 0.05$ was considered statistically significant. All analyses were performed using SPSS® Statistics software (version 28.0.0.1; IBM SPSS, Chicago, IL).

### Results

A total of 115 patients were initially enrolled in the study. Following the application of exclusion criteria, including incomplete follow-up (n=6), extruded disc herniation (n=4), vertebral fractures (n=2), osteoid osteoma (n=1), and rheumatoid arthritis (n=1), 100 patients were included in the final analysis. Demographic characteristics of the population stratified by age group are shown in Table 1. The cohort was evenly distributed across three age groups: 30 patients aged 20-35 years, 35 aged 36-50 years, and 35 aged over 50 years. Mean age, height, weight, and BMI values were appropriately matched within age brackets, with BMI progressively increasing with age.

| Age Group | Number of Patients | Mean Age ± SD (range) | Male / Female | Mean Height ± SD (cm) | Mean Weight ± SD (kg) | Mean BMI ± SD (kg/m²) |
|---|---|---|---|---|---|---|
| 20-35 years | 30 | 28.4 ± 4.1 (20-35) | 14 / 16 | 172.4 ± 7.1 | 70.3 ± 9.8 | 23.6 ± 2.8 |
| 36-50 years | 35 | 43.8 ± 4.2 (36-50) | 17 / 18 | 169.8 ± 6.5 | 74.6 ± 8.5 | 25.9 ± 2.4 |
| >50 years | 35 | 62.3 ± 6.5 (51-75) | 16 / 19 | 167.2 ± 6.9 | 76.1 ± 7.9 | 27.3 ± 2.7 |

**Table 1:** Demographic characteristics of the study population stratified by age group. Data are presented as mean ± Standard Deviation (SD) with ranges in parentheses.

At baseline, there were no statistically significant differences in VAS, ODI, or PSQI scores between the three age groups ($p > 0.05$). After six months of mattress use, no group showed a statistically significant reduction in VAS scores ($p > 0.05$), although a trend toward improvement was observed, particularly in the >50 age group. At the 12-month follow-up, all groups showed significant within-group improvements in VAS, ODI, and PSQI scores compared to baseline ($p < 0.01$). Notably, patients in the >50 years group exhibited a significantly greater reduction in VAS scores (mean reduction 3.8 ± 1.0) compared to the 20-35 and 36-50 groups (mean reductions 2.0 ± 1.3 and 2.6 ± 1.1 respectively; $p < 0.05$), as shown in Table 2. Similarly, ODI scores showed a marked functional improvement across all groups, with the >50 age group again demonstrating the most pronounced change. PSQI scores indicated improved sleep quality over time, with final mean values falling within the normal sleep quality threshold only in the >50 years group. ANOVA analysis confirmed statistically significant differences between age groups for all three outcomes at 12 months (VAS: $F = 19.33$, $p < 0.001$; ODI: $F = 33.55$, $p < 0.001$; PSQI: $F = 20.83$, $p < 0.001$), suggesting that the clinical benefit of the mattress may be more pronounced in older adults.

| Age Group | VAS Baseline | VAS at 6 Months | VAS at 12 Months | ODI Baseline | ODI at 6 Months | ODI at 12 Months | PSQI Baseline | PSQI at 6 Months | PSQI at 12 Months |
|---|---|---|---|---|---|---|---|---|---|
| **Group 1** | 6.8 ± 1.2 (5-9) | 6.2 ± 1.1 (5-8) | 4.8 ± 1.3 (3-7) | 38 ± 7 (30-50) | 35 ± 6 (28-42) | 28 ± 5 (22-35) | 9.2 ± 1.5 (7-12) | 8.5 ± 1.4 (7-10) | 6.5 ± 1.2 (5-8) |
| **Group 2** | 7.1 ± 1.0 (6-9) | 6.0 ± 1.2 (5-8) | 4.5 ± 1.1 (3-6) | 42 ± 6 (35-48) | 36 ± 5 (30-40) | 26 ± 4 (20-32) | 9.5 ± 1.2 (8-11) | 8.2 ± 1.3 (7-10) | 6.2 ± 1.1 (5-8) |
| **Group 3** | 7.4 ± 1.1 (6-10) | 5.9 ± 1.3 (5-8) | 3.6 ± 1.0 (2-5) | 45 ± 8 (36-55) | 34 ± 7 (28-43) | 20 ± 5 (15-28) | 9.8 ± 1.4 (8-12) | 7.9 ± 1.2 (6-10) | 5.0 ± 0.9 (4-7) |

**Table 2:** Clinical outcomes at baseline, 6 months, and 12 months for each age group. Values are presented as mean ± Standard Deviation (SD), with minimum and maximum values in parentheses. Outcomes include pain intensity measured by the Visual Analog Scale (VAS), functional disability assessed using the Oswestry Disability Index (ODI), and sleep quality evaluated via the Pittsburgh Sleep Quality Index (PSQI).

## Discussion

The results of this study confirm the initial hypothesis: daily use of the MagniStretch® mattress was associated with statistically significant improvements in pain, functional status, and sleep quality in patients affected by chronic low back pain, particularly after 12 months of use. Notably, patients over the age of 50 experienced greater clinical benefit compared to younger age groups. This age-dependent response may reflect increased spinal stiffness, altered disc hydration, and baseline functional compromise typical in older adults, making them more responsive to passive spinal decompression mechanisms. The magnitude of pain reduction, as assessed by the Visual Analog Scale (VAS), aligns with the expected therapeutic goals of conservative management strategies for non-specific low back pain. While improvements at 6 months were not statistically significant, the 12-month data demonstrated a consistent and meaningful reduction in VAS scores, especially in the >50 age group (mean reduction of 3.8 points), exceeding the Minimal Clinically Important Difference (MCID) commonly cited in the literature [8]. These findings suggest that a longer duration of consistent use is necessary for biomechanical mattresses like MagniStretch® to exert their full therapeutic potential. The Oswestry Disability Index (ODI), a well-validated measure of functional impairment, also showed notable reductions across all groups. The >50 years cohort demonstrated the greatest improvement, supporting the idea that passive spinal support during rest can translate into meaningful gains in daily functionality. This result is consistent with findings by Minetto et al. [1], who reported that an innovative mattress overlay with directional elasticity contributed to improved ODI and rehabilitation outcomes in chronic low back pain patients. Sleep quality, as measured by the Pittsburgh Sleep Quality Index (PSQI), showed gradual but significant improvement over the study period.

Chronic pain is a well-known disruptor of sleep, and poor sleep, in turn, exacerbates pain sensitivity and functional decline [9]. The notable improvement in PSQI scores-especially in the older cohort-suggests that spinal realignment and pressure redistribution during sleep may enhance nocturnal comfort and reduce micro-arousals, a benefit not typically addressed by conventional orthopedic or memory foam mattresses. Biomechanically, the MagniStretch® mattress is engineered to promote passive vertebral elongation using body weight-generated longitudinal tension. This design mimics spinal unloading techniques seen in physical therapy and traction-based rehabilitation but operates during rest, requiring no active engagement by the user. Previous biomechanical studies have shown that such decompression strategies may reduce intradiscal pressure and improve disc space height [10], which could partly explain the delayed but substantial improvements observed at 12 months. Interestingly, the absence of significant clinical change at 6 months across groups underscores the slow-acting but progressive nature of this intervention. It contrasts with pharmacological or manual therapies that may offer faster relief but often without sustained benefit. In this context, the MagniStretch® mattress represents a non-invasive, low-risk intervention that can complement other conservative therapies and enhance long-term outcomes. From a translational perspective, the strong effect seen in older adults suggests potential value for targeted use in geriatric patients or individuals with limited access to active rehabilitation. It may also reduce reliance on analgesics, a critical concern given the risk of opioid dependence in chronic musculoskeletal pain management [11].

This study presents several methodological strengths that enhance the validity and clinical relevance of its findings. First, the prospective design and extended 12-month follow-up period allowed for an accurate assessment of both short- and long-term outcomes, capturing the delayed but sustained benefits associated with biomechanical mattress use. Second, the use of standardized and widely validated clinical instruments, VAS, ODI, and PSQI, ensures comparability with existing literature and strengthens the interpretability of the results. Third, the inclusion of a well-characterized cohort stratified by age enabled subgroup analyses, revealing age-related differences in clinical response that may guide personalized interventions. Additionally, the relatively large sample size (n=100) with low attrition supports the robustness of the findings, and the real-world clinical setting enhances generalizability to everyday practice. Despite its strengths, this study has several limitations that should be acknowledged. First, the absence of a control group using a standard or placebo mattress limits the ability to attribute improvements exclusively to the MagniStretch® design; future randomized controlled trials are necessary to confirm causality. Second, all outcome measures were patient-reported, introducing the potential for subjective bias, particularly in pain and sleep assessments. Third, although efforts were made to standardize instructions and monitor adherence, compliance with mattress use was self-reported and not objectively verified. Fourth, the study did not control for concurrent lifestyle factors, such as physical activity levels, sleep hygiene, or medication use, which may have influenced outcomes. Additionally, the cohort was drawn from a single clinical center, which may limit generalizability across broader populations or different healthcare systems. Lastly, the exclusion of patients with structural spinal disorders or comorbidities limits applicability to more complex or heterogeneous cases of low back pain.

## Conclusion

The findings of this study demonstrate that consistent use of the MagniStretch® mattress is associated with significant improvements in pain intensity, functional capacity, and sleep quality in patients with chronic low back pain, particularly after 12 months of use. The

therapeutic effects were most pronounced in patients over the age of 50, suggesting that age-related spinal biomechanics may influence clinical responsiveness to passive spinal decompression during sleep. These results highlight the potential of biomechanically engineered mattresses as non-invasive, supportive interventions in the long-term management of nonspecific low back pain. While further randomized controlled trials are needed to validate these findings and control for potential confounding factors, the present study contributes meaningful preliminary evidence supporting the clinical utility of the MagniStretch® system as an adjunctive tool in spinal care.

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