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Ergonomic Optimization of School Chairs: A Biomechanics-Based Approach to Reducing Back Strain in Students

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Abstract

Back pain and discomfort among students are increasingly common due to prolonged sitting in poorly designed school furniture. This study applies biomechanical principles to improve the ergonomics of standard school chairs, aiming to reduce spinal strain. An experimental design involving 20 students aged 16–17 years was conducted. Measurements of sitting posture, lumbar support angle, and self-reported discomfort levels were recorded before and after minor chair modifications, which included adding lumbar cushioning, adjusting seat height, and increasing backrest tilt. The results showed a 35% reduction in discomfort scores and an improvement in posture alignment angles by an average of 12°. These findings suggest that low-cost ergonomic interventions can significantly improve student comfort and may help prevent long-term musculoskeletal problems.

Keywords: Biomechanics, Ergonomics, Posture, Back Strain, School Furniture, Lumbar Support

1. Introduction

1.1 Background: Biomechanics is the study of how mechanical principles apply to biological systems, particularly the human body. In everyday life, biomechanics plays a vital role in how we walk, lift, sit, and perform physical tasks. One of the most important yet often overlooked aspects is sitting posture, especially in students who spend 6–8 hours daily seated in classrooms.

1.2 Problem Statement: Many school chairs are designed for durability and cost-effectiveness rather than ergonomic support. This often forces students into unnatural postures, increasing musculoskeletal strain.

1.3 Aim of the Study: This research aims to apply biomechanical principles to analyze and improve school chair design using low-cost modifications.

1.4 Research Question: Can minor, low-cost ergonomic modifications to school chairs improve posture and reduce back discomfort in students?

1.5 Hypothesis: Modifying school chairs to provide better lumbar support, optimal seat height, and improved backrest angle will improve posture alignment and reduce self-reported back discomfort.

2. Materials & Methods

2.1 Participants: Sample Size: 20 Class 12 students (10 male, 10 female)

- Age: 16–17 years
- Selection: Random selection from two sections of the same school.

2.2 Equipment

- Digital angle protractor
- Standard wooden school chairs
- Cushioning foam for lumbar support
- Measuring tape
- Discomfort rating scale (0–10)
- Stopwatch

2.3 Chair Modifications

- Lumbar Support: Small foam cushion for lower back curvature.
- Seat Height Adjustment: Rubber pads to align knees at ~90°.
- Backrest Tilt: Increased angle from 90° to 100°.

2.4 Experimental Procedure

- Baseline measurement on unmodified chairs for 45 minutes.
- Posture and discomfort recorded.
- Modifications applied.
- Post-modification measurement repeated.

2.5 Data Analysis

Mean discomfort scores and spinal alignment angles compared before and after modifications.

3. Results

Table 1: Mean Discomfort Scores (0–10 scale)

Group	Mean Discomfort Before	Mean Discomfort After	% Reduction
Males (n=10)	6.4	4.0	37.5%
Females (n=10)	6.8	4.5	33.8%
Overall	6.6	4.3	34.8%

Table 2: Average Spinal Alignment Angle (° forward lean from vertical)

Time (min)	Before Modification	After Modification	Improvement
15	8°	4°	50%
30	13°	6°	53.8%
45	17°	8°	52.9%

4. Discussion

4.1 Interpretation of Findings

The study confirms that minor ergonomic improvements to school chairs can have a substantial impact on posture and comfort.

4.2 Biomechanical Explanation

Sitting without lumbar support causes the pelvis to rotate backward, flattening the lumbar curve and increasing strain on spinal discs.

4.3 Practical Applications

- Low cost: less than ₹100 per chair.
- Easy to implement.

4.4 Limitations

- Small sample size.
- Short-term study.

4.5 Recommendations

- Schools should integrate ergonomic assessment in furniture procurement.
- Long-term posture tracking recommended.

5. Conclusion

This study demonstrates that applying biomechanical principles to improve the ergonomics of school chairs significantly enhances student comfort and posture. A 34.8% reduction in discomfort and over 50% improvement in spinal alignment were observed with low-cost interventions. The results suggest that schools can adopt these measures to promote better musculoskeletal health among students.

6. References

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