Using Arduino-Based Components to Analyze Biomechanical Forces Against Qualitative Feedback

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This engineering project develops a low-cost, portable device to quantify back pain risk in youth, aiming to reduce progression of chronic spinal conditions. Back pain affects 39% of adults (CDC, 2019) and disproportionately impacts lower-income populations. My guiding key design constraints were affordability (<$100), accessibility, and scalability using commercially available components. The prototype integrates RP-S40-ST analog pressure sensors beneath backpack straps to measure vertical spinal load, and accelerometers to capture dynamic forces (“jolt”). Pressure data is collected via Arduino, while acceleration is recorded through a mobile application, producing synchronized numerical outputs. Student participants walked standardized distances at controlled speeds with varying backpack configurations. Peak and baseline sensor values were compared to perceived discomfort using a Likert-scale survey. Results show a strong positive correlation between increased sensor outputs and reported discomfort, validating the system as a model of real-world biomechanical strain. Iterative improvements include transitioning from one- to three-dimensional acceleration, increasing sensor integration, and developing a unified interface with Data Streamer for real-time visualization and storage. Future work focuses on a durable device casing, algorithms approximating muscle response (inspired by tensiomyography), and a controlled “strap adjustment” test to correlate backpack length with torque. A Bluetooth-enabled mobile app is in development to centralize data. A classroom kit is also being designed to expand testing and promote STEM education.

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