

# LOW-COST REHABILITATION EXERCISE SAFETY DEVICE FOR ENHANCED ACCESSIBILITY

**David C. Paulus<sup>1</sup>, Luke D. Paulus<sup>2</sup>, Emma C. Paulus<sup>1</sup>**

1. University of Arkansas, Fayetteville, AR

2. Southside Highschool, Fort Smith, AR

**Corresponding Author: David C. Paulus, Ph.D., PE**

**Email: [dpaulus@uark.edu](mailto:dpaulus@uark.edu)**

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## ABSTRACT

This study presents the development of a low-cost safety braking system designed for use during strength rehabilitation training. The primary goal of the device is to improve accessibility to rehabilitation equipment and reduce the risk of injury particularly when a physical therapist is unavailable including for users with disabilities. The proposed solution is an apparatus that stops barbell movement when a brake lever is engaged. For instance, if a user experiences pain or is unable to return the barbell to the rack height, pulling the brake lever halts the barbell's downward motion, allowing the user to recover or safely exit. Testing of the proof-of-concept prototype demonstrated the device's ability to stop the downward motion of a weighted barbell when the lever was engaged, supporting loads up to 95 lb. These results indicate that the device enhances safety by enabling users to perform rehabilitation exercises without the need for a spotter using a low-cost disc brake system that can be retrofitted to any standard free-weight squat rack. The system allowed the barbell to move freely when unracked and held stationary when the lever was engaged without requiring additional upward force. A survey of potential users gathered insights for future improvements prior to human subject testing. This research outlines the prototype development process and demonstrates its potential to reduce risks associated with unsupervised rehabilitation exercise. Further design refinements and testing with human participants are necessary to optimize the device's effectiveness and usability, providing a safer and more accessible rehabilitation experience.

**Keywords:** Rehabilitation, Exercise, Safety, Accessibility, Low-Cost

## INTRODUCTION

This study outlines the potential benefits, development process, and functionality of a comparatively low-cost free-weight spotting system that can be attached to a standard squat rack cage to be used during barbell exercises. While the proposed device can be used for many other barbell exercise, this study will focus primarily on the application for bench pressing. This machine features a braking system that can suspend the weight of the barbell in place to prevent the weights from causing injury to the participant. Injury can be caused when muscle failure precludes the participant from returning the bar to the height required to "rack the weights". If the barbell cannot be returned to the height necessary to rack the weights, the weights can fall, resulting in striking or choking the weightlifter. This study created proof of concept of a design that can mitigate some of the risks faced by those participating in bench press and other exercises. *Merriam-Webster* defines a proof of concept as "something that demonstrates the feasibility of a concept (such as a product idea or a business plan)" [1]. The concept to be proven by the authors is the creation of an apparatus with the ability to suspend a barbell loaded with weights. Though there are patents for devices with similar functions, the particular method of suspending the barbell described herein has not been implemented in a publication before to the authors' knowledge. This conceptual prototype is important for developing lower cost alternative methods of improving the safety of rehabilitation resistance training compared to existing rehabilitation devices such as isokinetic exercise equipment which can cost over \$100,000. With innovations in weightlifting safety, more options become available giving the public access to a wider variety of devices that can be used to prevent injury. Even failed attempts can bring knowledge to an inventor