

# DESIGN, CONSTRUCTION, AND TESTING OF A DIFFERENTIAL RESISTANCE ELLIPTICAL EXERCISE MACHINE (DREEM) TO REDUCE LEG STRENGTH ASYMMETRY POST-STROKE

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## ABSTRACT

Stroke is a primary cause of long-term disability. A common outcome is hemiparesis, an imbalance of muscular strength and poor motor control between the two body sides. Resulting gait abnormalities beget compensatory motor patterns, leading to overuse of the stronger leg resulting in pain and injuries. Emerging research indicates that differential leg resistance during exercise may help reverse these effects; however, the size and expense of existing commercial devices may prohibit home use for many. Elliptical machines show promise due to their inherent mechanical simplicity, compactness, and affordability. Here, we present the design, construction and pilot testing of a novel Differential Resistance Elliptical Exercise Machine (DREEM). Design constraints included motor assistance, “free-wheeling” (allows the user to pedal faster than the motor and encounter resistance), and walker accessibility. It was hypothesized that by altering the crank arm length on one side, differential forces between legs could be achieved and controlled. A device was prototyped with a forward flywheel configuration so that it was compatible with a commercial walker. The device was user tested with load cells coupled to each pedal and a motion capture system. The results indicated that shortening one crank arm increased the mean forces exerted by the associated leg, providing preliminary evidence for an affordable home-based rehabilitative exercise device for those living post-stroke.

**Keywords:** exercise, elliptical, differential force, stroke, hemiparesis

## INTRODUCTION

People living with mobility impairments include individuals with acquired locomotor deficits (e.g., post-stroke hemiparesis), who are likely to experience further decline in health and function due to the lack of physical activity. Secondary conditions, such as obesity and cardiovascular disease, increase morbidity/mortality and reduce quality of life for this population. The economic costs of physical inactivity among those with disabilities were estimated to be over \$700 billion annually [1]; thus, prevention of secondary conditions is extremely important for this population [2-4].

Exercise has been clearly linked to the reduction of secondary conditions and improving health and function in people with disabilities [5], contributing significantly to overall physical and mental well-being [6,7]. For individuals post-stroke, the AEROBICS 2019 Update recommended that aerobic training be incorporated into rehabilitation [6]. Multiple barriers, however, lead to decreased physical activity among this population, including environmental and physical barriers [7,8], cost and transportation [9-