Virtual Neuromuscular Training to Reduce Injury Risk After Concussion: A Pilot Study in Healthy Adults

University of Colorado Anschutz Medical Campus

Samantha Magliato, BS[01], Mathew Wingerson, MS[02], Casey Little, BS[02], Katherine Smulligan, DPT[01], Julie Wilson, MD[01,02,03], David Howell, PhD, ATC[01,02]

[01]Department of Orthopedics, University of Colorado School of Medicine, CO, USA
[02]Sports Medicine Center, Children's Hospital Colorado, CO, USA
[03]Department of Pediatrics, University of Colorado School of Medicine, CO, USA

SPORTS MEDICINE CENTER Children's Hospital Colorado

Background

- Sports-related concussion is associated with an increased risk of musculoskeletal injury following return-to-play
- Current return-to-play strategies may ineffectively meet the complex cognitive and motor demands of sport
- Interventions affecting neuromuscular control may reduce injury risk after concussion.

Purpose: To determine the feasibility and associated changes that occurred with an 8-week virtual Neuromuscular Training (vNMT) program using a novel, smartphone-based platform in healthy adults

Virtual Smartphone Platform

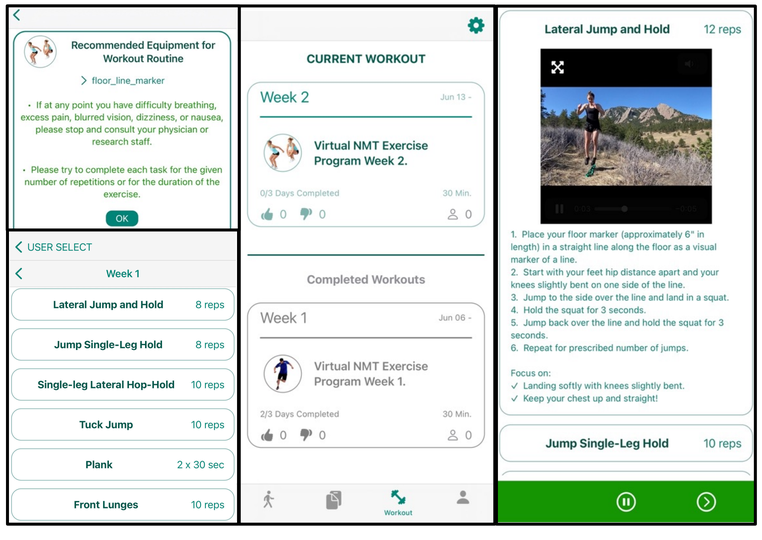

Figure 1. Screenshots from the IMPROVE application on a smartphone device

Methods

Figure 2. Study Flow Diagram

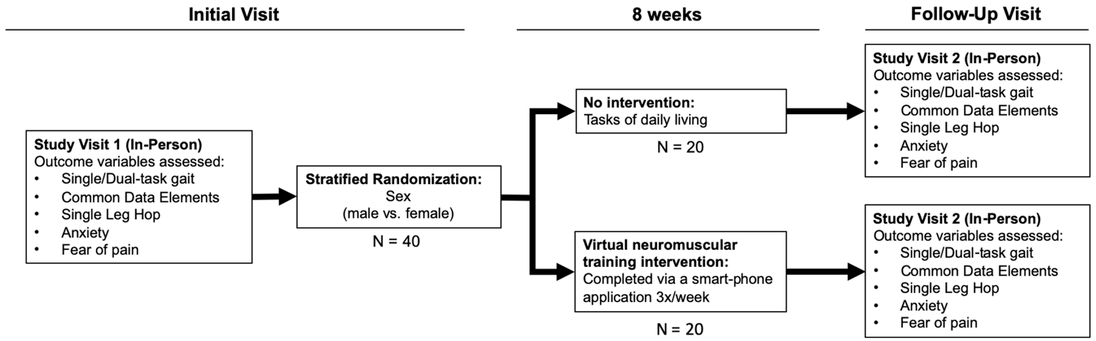

Table 1. Description of self-reported and clinician-obtained performance measures.

Variable	Description
Self-Reported Measures	
Sleep Quality (PSQI)	The Pittsburgh Sleep Quality Inventory is a validated scale to calculate sleep duration and elements contributing to overall sleep quality.
Confidence in Movement Scale	The Adolescent Measure of Confidence and Musculoskeletal Performance is a validated measure used to assess confidence in movement abilities following injury.
Dizziness Handicap Index	Identifies problems related to dizziness in everyday life.
Tampa Scale of Kinesiophobia	A valid outcome measure used to identify post-concussion fear of pain with movement.
GAD-7	The Generalized Anxiety Disorder-7 is used as a brief screening tool and severity measure for GAD.
Clinician Obtained Measures	
Single-task and dual-task Tandem Gait	Participants walk heel-to-toe, as quickly as possible, along a 3-meter strip of tape, make a 180-degree turn at the end of the tape and return to the starting point with the same heel-to-toe gait. In the dual-task condition, participants complete a cognitive task while simultaneously walking heel-to-toe.
BESS	Balance Error Scoring System is a static balance assessment performed under 2 stance conditions: single-leg and tandem stance.
Reaction time (RT)	Reaction time was measured using both drop stick and smartphone techniques. Drop stick RT measures time required to catch a suspended vertical shaft by hand closure. Smartphone RT measures the speed at which patients respond to a simple on-screen stimulus.
Triple hop test	Participants perform a triple hop for distance test by performing 3 consecutive maximal single leg hops forward on each limb.
Multiple hop test	Participants perform a multiple hop test to assess dynamic postural control by hopping with their dominant limb along a multi-directional pattern of ten floor markers.

Results

- At the time of analysis, n=18 participants had completed both pre and post intervention visits:
  - 8 vNMT (24.9±1.1 years; 75% female)
  - 10 control (26.4±3.0 years; 70% female)
- We observed **no significant between-group differences** for any measurement obtained:
  - This was somewhat expected, given we were testing non-impaired individuals
- The vNMT group demonstrated fewer errors in the **multiple hop test** at the post-intervention assessment compared to the control group, although this did not reach statistical significance:
  - Pre-Intervention errors: vNMT=2.2(1.3), Control=2.2(1.3); p=0.97
  - Prost-Intervention errors: vNMT=1.1(0.8), Control=2.1(1.3); p=0.10
  - Cohen's d = 0.84

Implications

- Necessary first step in assessing the efficacy of a smartphone-based rehab program in a healthy population

Goal: To shift clinical practice by integrating this model into concussion management to reduce musculoskeletal injuries following return-to-sport after concussion

Acknowledgements

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