

Electronic Handgrip Dynamometry and Accelerometry Derived Muscle Function

are Associated with Lower Extremity Strength in Older Adults

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Abstract

PURPOSE: Conventional handgrip dynamometers only allow for the feasible measurement of overall muscle strength. Electronic handgrip dynamometry and accelerometry is a novel collection method that allows for the opportunity to ascertain more attributes of muscle function beyond strength capacity while also preserving feasibility. However, the role of this new muscle function collection mode on lower extremity muscle strength remains unknown. We sought to determine the associations between electronic handgrip dynamometry and accelerometry derived muscle function on lower extremity strength in older adults. **METHODS:** We utilized an observational design for this investigation. Data were collected from n=121 generally healthy adults aged at least 65-years (age: 70.8±4.8 years; 67.0% female). Electronic handgrip dynamometers and accelerometers were used to measure individual attributes of muscle function: strength, submaximal control, rate of force development, and neuromuscular steadiness. Isokinetic dynamometry was used to collect knee extension strength. Linear regression models were used for the analyses. **RESULTS:** Strength ($\beta=2.63$; $p<0.01$), sub-maximal control ($\beta=-1.22$; $p<0.01$), rate of force development ($\beta=0.51$; $p<0.01$), and neuromuscular steadiness ($\beta=0.62$; $p<0.01$) were each associated with lower extremity strength.

CONCLUSIONS: Electronic handgrip dynamometry and accelerometry derived strength, sub-maximal control, rate of force development, and neuromuscular steadiness were linked with lower extremity strength. These findings suggest that a signal exists for using electronic handgrip dynamometry and accelerometry to serve as indicators for whole body muscle function. However, more research is needed to examine how each aspect of muscle function as measured by electronic handgrip dynamometry and accelerometry is linked to such individual aspects in the lower extremities. **PRACTICAL APPLICATIONS:** Handgrip dynamometry is a feasible method for collecting overall muscle strength, especially in older populations. Sports medicine practitioners are encouraged to utilize handgrip dynamometers to assess strength capacity as appropriate. Electronic handgrip dynamometers and accelerometers provide advancements in methods and instruments, which may have promise for providing more insights regarding muscle health than conventional handgrip dynamometers.

Introduction

- Electronic handgrip dynamometry and accelerometry offer new and innovative opportunities to feasibly collect additional attributes of muscle function beyond maximal strength.
- Examining the role of these measures on lower extremity muscle function may provide a signal for how these attributes might be connected.
- This study determined the associations between electronic handgrip dynamometry and accelerometry derived muscle function on lower extremity strength in older adults.

Methods

Participants

Design

- An observational design was used for this investigation.
- The North Dakota State University Institutional Review Board approved all protocols.
- Participants provided written informed consent before study entry.

Recruitment

- Flyers, campus listservs, institutional research registries, word-of-mouth.

Study Criteria

- Inclusion: Adults aged ≥ 65 -years.
- Exclusion: Undergoing cancer treatment; living with a neurodegenerative condition; not ready to engage in physical activity; unable to extend and curl a leg at the knee; unable to squeeze a handgrip dynamometer on both hands.

Measures

Knee Extension Strength

- Biodex System 4 Pro isokinetic dynamometer.
- 60° contraction velocity on self-reported dominant leg.
- Warm-up set of 4 repetitions for familiarity.
- A set of extension and flexion at maximal effort for 5 repetitions.

Electronic Handgrip Dynamometry and Accelerometry

Biopac electronic dynamometers and ActiGraph GT3X-BT accelerometers collected:

- Strength (kilograms)=maximal force generated
- Asymmetry (ratio)=strength imbalance between hands
- Submaximal control (coefficient of variation)=submaximal force for a duration
- Rate of force development ($\Delta\text{force}/\Delta\text{time}$)=force generation as quickly as possible
- Bimanual coordination (ratio)=simultaneous force generation between limbs
- Fatigability index (%)=strength maintenance for as long as possible
- Contractile steadiness (vector magnitude)=tremoring from contracting muscles



Conventional Handgrip Dynamometry



Electronic Handgrip Dynamometry and Accelerometry

Statistical Analysis

- All analyses were performed with SAS 9.4 software (SAS; Cary, NC).
- Crude and covariate-adjusted linear regression models examined the associations between each grip force task and knee extension strength.
- An alpha level of 0.05 was used for all analyses.

Results

- There were 121 participants included aged 70.8±4.8 years and 67.0% were female.

Table 1. Associations of Electronic Handgrip Dynamometry and Accelerometry on Knee Extension Strength.

	Crude		Covariate-Adjusted	
	β	95% Confidence Interval	β	95% Confidence Interval
Strength	2.63*	2.16, 3.10	1.66*	0.94, 2.39
Asymmetry	-14.54	-60.47, 31.39	14.77	-20.55, 50.10
Submaximal Control	-1.22*	-2.10, -0.33	-0.49	-1.21, 0.21
Rate of Force Development	0.51*	0.34, 0.67	0.20*	0.04, 0.36
Bimanual Coordination	7.23	-35.0, 49.5	-6.41	-37.9, 25.0
Fatigability	0.17	-0.19, 0.54	0.07	-0.19, 0.35
Contractile Steadiness	0.62*	0.21, 1.02	0.44*	0.13, 0.75

* $p<0.05$.

Conclusions

- Electronic handgrip dynamometry and accelerometry derived strength, rate of force development, and contractile steadiness were linked with knee extension strength.
- These findings suggest that a signal exists for using electronic handgrip dynamometry and accelerometry to serve as indicators for whole body muscle function.
- More research is needed to examine how each aspect of muscle function as measured by electronic handgrip dynamometry and accelerometry is linked to such individual aspects in the lower extremities.

Practical Applications

- Handgrip dynamometry is a feasible method for collecting overall strength, especially in older population.
- Sports medicine practitioners are encouraged to utilize handgrip dynamometers to assess strength capacity as appropriate.

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