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Original Study

Handgrip Strength Cannot Be Assumed a Proxy for Overall Muscle Strength

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A B S T R A C T

Objectives: Dynapenia, low muscle strength, is predictive for negative health outcomes and is usually expressed as handgrip strength (HGS). Whether HGS can be a proxy for overall muscle strength and whether this depends on age and health status is controversial. This study assessed the agreement between HGS and knee extension strength (KES) in populations differing in age and health status.
Design: Data were retrieved from 5 cohorts.
Setting and Participants: Community, geriatric outpatient clinics, and a hospital. Five cohorts (960 individuals, 49.8% male) encompassing healthy young and older individuals, geriatric outpatients, and older individuals post hip fracture were included.
Measures: HGS and KES were measured according to the protocol of each cohort. Pearson correlation was performed to analyze the association between HGS and KES, stratified by sex. HGS and KES were standardized into sex-specific z scores. The agreement between standardized HGS and standardized KES at population level and individual level were assessed by intraclass correlation coefficients (ICC) and Bland-Altman analysis.
Results: Pearson correlation coefficients were low in healthy young (male: 0.36 to 0.45, female: 0.45) and healthy older individuals (male: 0.35 to 0.37, female: 0.44), and moderate in geriatric outpatients (male and female: 0.54) and older individuals post hip fracture (male: 0.44, female: 0.57) ($P < .05$, except for male older individuals post hip fracture [$P = .07$]). Intraclass correlation coefficient values were poor to moderate in all populations (ie, healthy young individuals [0.41, 0.45], healthy older individuals [0.37, 0.41, 0.44], geriatric outpatients [0.54], and older individuals post hip fracture [0.54]). Bland-Altman analysis showed that within the same population of age and health status, agreement between HGS and KES varied on individual level.

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Conclusions: At both population and individual level, HGS and KES showed a low to moderate agreement independently of age and health status. HGS alone should not be assumed a proxy for overall muscle strength.

Measurement of muscle strength is an important part of the comprehensive geriatric assessment[1] because of its predictive validity for decline in cognition, mobility, and functional status in community-dwelling older individuals.[2–4] Low muscle strength, known as dynapenia, is also associated with an increased risk of postoperative complications, prolonged length of stay, and mortality in hospitalized or postsurgical patients.[5,6] Muscle strength is part of the diagnostic criteria for sarcopenia, which is defined as low muscle mass and low muscle function (muscle strength and/or physical performance), depending on the applied definition.[7]

In clinical practice, quantification of muscle strength in older individuals is predominantly assessed by measuring handgrip strength (HGS) as the measurement is simple and the device is portable and inexpensive.[7] In addition to HGS, muscle strength can be assessed by measurement of knee extension strength (KES). This method is, however, more technically challenging and not widely accessible.[8] It has been shown that the decline of muscle strength with chronological age is greater for the lower limb muscles than that of the upper limb.[9–11] Previous studies showed a high association between HGS and KES among healthy individuals aged 18–90 years[12–14] and a low association among geriatric outpatients.[15] Furthermore, previous studies used correlation coefficients quantifying the degree to which 2 variables are related on a population level, but not at individual level.

The aim of this study was to assess the agreement between HGS and KES in various populations of individuals differing in age and health status at population and individual level.

Methods

Study Design

Data were derived from 5 cohorts including 960 individuals encompassing healthy young and older individuals, geriatric outpatients, and older individuals post hip fracture.

MyoAge cohort

Healthy young and older individuals were derived from the European MyoAge cohort. The study rationale and design is reported in detail elsewhere.[16] The MyoAge cohort included healthy young (aged 18–30 years) and older individuals (aged 69–81 years) recruited from 5 centers located in the United Kingdom (Manchester), France (Paris), The Netherlands (Leiden), Estonia (Tartu), and Finland (Jyväskylä). Exclusion criteria included inability to walk for a distance of 250 m, being institutionalized, morbidities (neurologic disorders, metabolic diseases, rheumatoid arthritis, recent malignancy, heart failure, coagulation diseases, chronic obstructive pulmonary disease), using immunosuppressive drugs, insulin, and anticoagulants, fracture over the previous year, immobilization for 1 week over the previous 3 months, and orthopedic surgery during the past 2 years or still causing pain or physical limitation. All study centers adopted the same standardized operation procedure to perform the measurements of muscle strength. In the present analysis, data on HGS and KES were available in 181 healthy young individuals and 320 healthy older individuals.

Manchester Metropolitan University cohort

This cohort encompasses healthy young and older male individuals aged 18–40 years or 60–90 years who were recruited as part of a study investigating the nature and extent of motor unit changes in the vastus lateralis of individuals.[17] Young individuals were recruited from the university and local communities around Manchester, United Kingdom. Older individuals were recruited from the local community. Exclusion criteria were recent history of leg bone fracture, diagnosis with any form of cancer or a stroke within the past 2 years, immobilization for more than 5 days within the past 4 weeks, diagnosis of any neuromuscular disease or dementia at any time, not living independently, and body mass index <18 or >35 kg/m^2. In the present analysis, data on HGS and KES were available in 42 young and 108 older individuals.

Dehydroepiandrosterone in older individuals cohort

This cohort examining oral dehydroepiandrosterone in older individuals (DHEAge) included healthy female and male individuals aged 60–80 years.[18] Individuals attended geriatric consultations in a geriatric outpatient clinic for various symptoms related to aging such as fatigue, memory complaints, pain, and anxiety. Data was collected before the administration of dehydroepiandrosterone. Exclusion criteria included diseases such as dementia, major depressive state, cardiovascular disorder, respiratory deficiency, Parkinson's disease, endocrine disorder, and antecedent of hormone-dependent cancer. In the present analysis, data on HGS and KES were available in 68 female individuals.

Geriatric outpatients

This inception cohort included community-dwelling older individuals referred due to mobility problems to a geriatric outpatient clinic in a middle-sized teaching hospital (Bronovo Hospital, The Hague, The Netherlands).[19] The comprehensive geriatric assessment included questionnaires and measurements of physical and cognitive function and was performed by trained nurses or medical staff. In the present analysis, data on HGS and KES were available in 163 outpatients.

Promoting Mobility after Hip Fracture cohort

This cohort includes community-dwelling older individuals aged 60 years and older with a hip fracture operated at the Central Finland Central Hospital, Finland.[20] Individuals were asked to participate in a randomized controlled trial investigating the effects of a rehabilitation program aiming to restore mobility and functional capacity. Baseline measurements were performed after individuals were discharged home from hospital, on average 65 ± 21 days after hip fracture operation. Exclusion criteria included being institutionalized or confined to bed at the time of the fracture, Mini-Mental State Examination score of <18 points, alcoholism, severe cardiovascular, pulmonary or progressive disease, para- or tetraplegic, or severe depression. In the present analysis, data on HGS and KES were available in 78 individuals.

Characteristics of the Different Cohorts

Demographics of individuals were assessed by questionnaires in the MyoAge, Promoting Mobility after Hip Fracture (ProMo), and