RESEARCH ARTICLE

CYPRUS
JOURNAL OF MEDICAL SCIENCES

DOI: 10.4274/cjms.2021.3213
Cyprus J Med Sci 2023;8(5):360-364

The Relationship Between Grip Strength and Reaction Time in Different Age Groups

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Abstract

BACKGROUND/AIMS: Hand grip strength (HGS) and reaction time are crucial functions to maintain daily activities. They are also a sign of general physical health. The aim of this study was to determine the relationship between grip strength and reaction time in children, adults and older adults.

MATERIALS AND METHODS: The study included a total of 120 subjects, comprising 40 children, 40 adults and 40 older adults. The Jamar Hydraulic Hand Dynamometer (Sammons Preston, Bolingbrook, Illinois) was used to evaluate HGS and the Nelson Hand Reaction Ruler was used for the upper extremity reaction time.

RESULTS: A statistically significant difference was determined between the three age groups with respect to grip strength ($p<0.001$) and reaction time ($p<0.001$). No statistically significant correlation was found between grip strength and reaction time of children ($r=-0.27$, $p=0.09$) and adults ($r=-0.22$, $p=0.18$). A statistically significant, negative, and strong correlation was found between grip strength and reaction time in older adults ($r=-0.53$, $p<0.001$).

CONCLUSION: The results of the study showed no relationship between the grip strength and reaction time of children and adults, whereas the grip strength levels of the older adults were seen to increase as reaction time decreased.

Keywords: Hand grip strength, reaction time, aging, older adult, adult

INTRODUCTION

The hand, which is a complex and highly differentiated organ, plays an important role in the sustainability of daily life activities.[1] The number and size of muscle fibres decrease as a result of age-related loss of spinal motor neurons, leading to impaired mechanical muscle performance that translates into reduced functional capacity for daily living activities.[2] Hand grip strength (HGS) and reaction time are the key factors during all functions of the upper extremity. The normative values of HGS and reaction time alone will provide more objective information about functional status.[3-6] However, the relationship between these two parameters has not yet been fully clarified.

HGS can be seen as a general indicator of the integrity of the central nervous system associated with cognitive variables.[7-9] Although there are studies reporting that the decrease in HGS is related to cognitive decline, it has also been reported that individual differences have an impact.[10,11] It can therefore be understood that there are conflicting views on the relationship between HGS and reaction time, and there are several different studies in litterature on this subject.[12-15] Several studies have examined a specific age group or either HGS or reaction time.[8,16] To the best of our knowledge, there are no studies that have examined the relationship between the reaction time and HGS of children. Most such studies have reported the relationship between HGS and cognition in older adults and thus, data related to adults and

To cite this article: Kanlı K, Yerlikaya T, Angın S. The Relationship Between Grip Strength and Reaction Time in Different Age Groups. Cyprus J Med Sci 2023;8(5):360-364

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Received: 17.11.2020
Accepted: 17.03.2021

children are still lacking.[7,17,18] The aim of this study was to determine the relationship between grip strength and reaction time in children, adults and older adults.

MATERIALS AND METHODS

This study was conducted in the Physical Therapy and Rehabilitation Department of the Near East University Medical Faculty Hospital, North Cyprus, between January 2018 and April 2018. Approval for the study was granted by the Scientific Research Ethics Committee of the Near East University (approval number: YDU/2018/54-490).

Participants

The study sample was selected from the relatives of patients who presented at the Near East University Hospital, students at the Near East Primary School and Secondary School, and individuals residing in the provinces of North Cyprus. Participants were chosen from healthy children aged 6 to 14, healthy adults aged 18-65 years and older adults aged 66-79 years, who had not presented at the clinic with any health-related problems within the last six months. While the children group was selected randomly from children at school, the other groups were selected randomly according to the hospital registration list.

Exclusion criteria for all groups were defined as:

- A history of mobility limiting musculoskeletal or neuromuscular disease, or upper extremity abnormalities,

- A history of upper extremity surgery,

- The presence of any communication problems.

Written informed consent for participation in this cross-sectional study was obtained from all the subjects, or from the parent or legal guardian of children below the age of majority. Personal information and anthropometric data of the participants were collected in face-to-face interviews. The demographic record form consisted of age, gender, height, weight, body mass index and dominant hand (Table 1).

Hand Grip Strength: Jamar Hydraulic Hand Dynamometer (Sammons Preston, Bolingbrook, Illinois)

The HGS evaluation of the participants was performed according to the standard measurement of the American Society of Hand Therapists: The subject is seated with the elbow positioned in 90º flexion and the hand positioned centrally with the thumb pointing upwards. The participants were instructed to squeeze the handles of the dynamometer as strongly as possible.[19] The Jamar dynamometer has five different handle positions: I-3.5 cm; II-4.8 cm; III-6.1 cm; IV-7.3 cm; and V-8.6 cm. The handle position was adjusted according to the hand size of the child, adult and older participants, and three different measurements were taken with a rest time of at least 30 seconds between each measurement. The mean value of the three measurements was calculated and recorded as kilogram units.[20]

Reaction Time: Nelson Hand Reaction Test

Each subject was placed in a sitting position on a chair, with the forearms and hands placed on the table in a comfortable position for the Nelson Hand Reaction Test. The hand was positioned so that the thumb and index fingers were 8 to 10 cm above the table, with the upper parts of the thumb and index fingers in a parallel position. The test supervisor placed and held a ruler between the thumb and index finger of the participants. The participants were instructed to look directly at the centre point of the ruler and then to catch the ruler when it was released by the supervisor. The value written on the upper part of the ruler, at the point where it was caught by the participant was recorded. Five measurements were recorded, and after exclusion of the best and worst values, the average of the other three measurements was calculated, and recorded as the distance to which the ruler fell. For each measurement, the value on the ruler was calculated according to the formula below and the reaction time of the participants was calculated. The formula: reaction time = $\sqrt{2}$ x Fall Distance of Ruler/ Gravity Related Speed Reaction Time = $\sqrt{2}$ x distance (cm)/980 sec.[21,22]

Statistical Analysis

Data obtained in the study were analysed statistically using SPSS version 24.00 software (IBM SPSS Statistics for Windows, IBM Corp., Armonk, NY, USA). As a result of the power analysis applied, it was calculated that when 120 participants were included in this study (40 subjects in each group), 80% power with 95% confidence interval would be obtained. The distribution of participants regarding the characteristic features of child, adult and older adult participants were defined by frequency analysis. Definitive statistics of age and anthropometric measurements were stated as mean, standard deviation, minimum and maximum values. The standard distribution compatibility of the data set, which was used to determine the hypothesis tests of the research was evaluated using the Kolmogorov-Smirnov and Shapiro-Wilk tests in respect of skewness-kurtosis values. As the data set was not compatible with normal distribution, non-parametric hypothesis tests were used.

Table 1. Descriptive features of the study groups

	Children, (mean ± SD)	Adults, (mean ± SD)	Older adults, (mean ± SD)
Gender (n, %)			
Female	21 (52.50%)	20 (50.00%)	19(47.50%)
Male	19 (47.50%)	20 (50.00%)	21(52.50%)
Age (years)	9.95±2.62	42.63±14.34	71.38±4.14
Height (m)	1.42±0.19	1.69±0.09	1.64±0.09
Weight (kg)	38.16±15.74	74.68±14.16	76.08±15.03
BMI (kg/m^2)	18.22±3.31	26.13± 4.57	28.47±5.51
Dominant hand (n, %)			
Right/Left	38 (95%)/2 (5%)	38 (95%)/2 (5%)	39 (97.50%)/1 (2.50%)

BMI: Body mass index, SD: Standard deviation.

The Kruskal-Wallis H test was used for the comparisons of grip strength and reaction time of the child, adult and older adult participants. Bonferroni correction was applied for the evaluation of the results. Correlations between grip strength and reaction time were evaluated using the Spearman's test. The statistical significance level was accepted as $p<0.05$

RESULTS

The comparison of grip strength in three groups are shown in Table 2. The average grip strength results were found to be 14.97±8.55 kg for children, 34.96±12.63 kg for adults and 26.57±9.80 kg for the older adults. A statistically significant difference was determined between the three age groups in respect of grip strength ($p<0.001$). When the differences were evaluated between the groups, the grip strength of adults was determined to be higher than that of children and older adults, and the grip strength of older adults was higher than that of the children.

The average reaction time was determined as 0.16±0.01 sec for children, 0.18±0.02 sec for adults and 0.19±0.02 sec for older adults. A statistically significant difference was determined between the three age groups in respect of reaction time values ($p<0.001$). The reaction time values of the children were lower than those of the adults and older adults, and the reaction time values of the adults were significantly lower than those of the older adults.

The correlation of grip strength values of the child, adult and older adult subjects are shown in Figure 1. No statistically significant correlation was determined between the grip strength and reaction time of the child ($p=0.09$) and adult subjects ($p=0.18$). A statistically significant, negative rotative, and moderate correlation was observed between grip strength and reaction time of the older adult subjects ($r=-0.53$, $p<0.001$).

DISCUSSION

The most important finding of this study was that the grip strength levels of older adults increased as reaction time decreased while the grip strength and reaction time of the children and adults showed no correlation. Reaction time and grip strength are essential measures to evaluate an individual in respect of both cognitive and physical function.[23] When literature was investigated regarding studies based on grip strength and reaction time, no study could be found which evaluated these two variables simultaneously within three different age groups. According to best of our knowledge this study is the first study showing the relationship between grip strength and reaction time in children, adults and older adults, the level of change in these variables and a map of the process.

With inevitable irreversible neuron losses, the ageing process causes movements to slow down and reaction time to be prolonged, while the decrease in type II muscle fibers required for force generation causes loss of muscle strength-mass with the increase of adipose tissue in the muscle fibers.[24-26] These two factors have a positive effect

Table 2. Comparison of grip strength and reaction time between the groups

Parameter	Group	Mean ± SD	Min.-Max.	Median	χ^2 (p)	η^2	Difference
Grip strength (kg)	Children[a]	14.97±8.55	2.33-34.00	12.15	46,210		[a-b]
	Adult[b]	34.96±12.63	18.00-62.60	31.80	<0.01	0.361	[a-c]
	Older adults[c]	26.57±9.80	8.33-48.00	26.65			[b-c]
Reaction time (sec)	Child[a]	0.16±0.01	0.10-0.19	0.16	48,199		[a-b]
	Adult[b]	0.18±0.02	0.13-1.21	0.18	<0.01	0.377	[a-c]
	Older adults[c]	0.19±0.02	0.15-0.21	0.19			[b-c]

SD: Standard deviation, Min.: Minimum, Max.: Maximum.

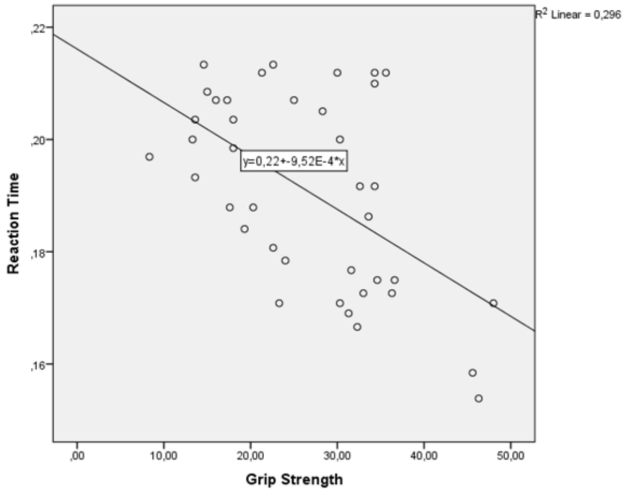

Figure 1. Correlations between merged grip strength and reaction time of three groups.

Table 3. Correlation between grip strength and reaction time of participants

			Grip strength (kg)			
			Children, (x̄14.97±8.55)	Adults, (x̄34.96±12.63)	Older adults, (x̄26.57±9.80)	Total, (x̄25.50±13.24)
Reaction time (sec.)	Children, (x̄1.81±0.32)	R	-0.27			
		P	0.09			
	Adults, (x̄2.31±0.46)	R		-0.22		
		P		0.18		
	Older adults, (x̄2.59±0.46)	R			-0.53	
		P			<0.001	
	Average, (x̄2.24±0.54)	R				0.07
		P				0.47

on the prevention of cardiovascular mortality in particular, while also increasing cognitive function and physical function.[27]

Age-related reductions in muscle mass have consistently been shown to be linked to changes in muscle activation and muscle recruitment characteristics, which have an impact on hand dexterity.[28] Age-related changes include slower muscle contraction speed, which slows neural conduction velocity, and increased muscle antagonist co-activation required to stabilize or restrict the joint during movement.[29,30]

Martin et al.[31] evaluated the relationship between hand dexterity and grip strength, and evaluated the reaction time of hand dexterity in individuals aged 18-93 years. All hand dexterity tasks were reported to have significantly declined with decreased strength in older adults whereas no relationship between strength and steadiness of hand dexterity was seen in younger adults. Those findings were similar to the results of the current study, although a child age group was not included.[31]

Bucsuházy and Semela[16] examined the difference between reaction times of child and adult groups and similar to the results of the current study, no significant difference was found. Choudhary et al.[23] reported a significant negative correlation between HGS in the dominant hand and visual reaction time in a study of adult kitchen workers. The results were contrary to the current study findings of our study, which can be considered to be due to increased function of the hand in occupational use.[23]

Reduction of grip strength and prolonged reaction time cause important secondary risks in older adults. Prolonged reaction time creates a more extended period in which to correct the balance and as a result of the decrease in muscle strength, the risk of falling increases with the insufficiency of muscle strength required to correct the balance. HGS measurements can be a useful part of clinical evaluations in older adults to identify individuals with reduced functional and cognitive health. Exercise and activities to improve muscle strength and to reduce reaction time are essential for older adults to reduce the risk of falls. There is also a need for further long-term research to determine whether regular sports activity during childhood and adulthood have any continued effect into old age.

Study Limitations

A limitation of this study was that a sufficient number of participants could not be reached to allow evaluation of all age groups according to decades. Another limitation was that although the ASHT protocol was followed, different postures during testing of the children may have affected the results.

CONCLUSION

The results of this study, which evaluated the relationship between grip strength and reaction time of children, adults and older adults, demonstrated that HGS was not associated with reaction time in children and adults, but a correlation was determined in older adults, with an increase in grip strength values as reaction time shortened. Thus, the reaction time was seen to be affected by age rather than strength, and the reaction time was affected by grip strength in old age.

MAIN POINTS

- Handgrip strength was not associated with the reaction time in children and adults.
- Reaction time was seen to be affected by age rather than strength, and the reaction time was affected by grip strength in old age.
- Handgrip strength is considered a meaningful measure of current physical health and future outcome in older adults.

ETHICS

Ethics Committee Approval: Approval for the study was granted by the Scientific Research Ethics Committee of the Near East University (approval number: YDU/2018/54-490).

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: S.A., Design: S.A., Supervision: S.A., Materials: K.K., Data Collection and/or Processing: K.K., Analysis and/or Interpretation: K.K., Literature Search: T.Y., Writing: T.Y., Critical Review: T.Y.

DISCLOSURES

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study had received no financial support.

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