TOJRAS The Online Journal of Recreation and Sports 12(4), 2023
ISSN: 2146-9598 Research Article

Investigation of the Relationship Between Cognitive Functions, Physical Activity and Strength in Healthy Middle-Aged Adults

Sağlıklı Orta Yaşlı Yetişkinlerde Kognitif Fonksiyonlar ile Kuvvet ve Fiziksel Aktivite Arasındaki İlişkinin İncelenmesi

Umut Canlı[1], *Cem Kurt[2]

[1] Tekirdağ Namık Kemal Üniversitesi Spor Bilimleri Fakültesi, Tekirdağ, TÜRKİYE / ucanli@nku.edu.tr / 0000-0001-8603-3492
[2] Trakya Üniversitesi, Kırkpınar Spor Bilimleri Fakültesi, Edirne, TÜRKİYE / cemkurt35@gmail.com / 0000-0002-0254-5923
* Corresponding author

Abstract: The purpose of this study was to investigate the relationship between strength and cognitive functions including selective attention and inhibitory response in healthy middle-aged adults. Thirty-one females and 12 males (N=43, age: 42.31±9.76 yr; Body mass: 71.42±14.85 kg; Height: 162.33±7.96 cm) were recruited for the study. They tested the hand-grip strength, 1RM bench press, 1RM leg press, 1RM long pulley, 1RM leg extension, and 1RM overhead press strength values of the participants, and cognition tests on separate days. Indirect 1 RM values were determined via a weight machine (Technogym Selection 900) and a formula. The handgrip strength level of the subjects' dominant side was assessed using a digital dynamometer. Selective attention of the subjects was measured by the d2 test and the inhibitory response of the subjects was measured by a computer-based Go/No-Go test. The multiple linear regression analysis showed no relationship between hand-grip strength, 1 RM strength values of bench press, leg extension, leg press, long pulley, overhead press, and cognitive functions. Based on these results, it can be concluded that the strength level of the subjects may not serve as a predictor of cognitive functions in healthy middle-aged adults. Further research with a larger sample size is necessary to fully elucidate the relationship between strength level and cognitive functions in middle-aged healthy adults.

Keywords: One-repetition maximum, hand-grip, attention, inhibition, regression analysis.

Özet: *Bu çalışmanın amacı sağlıklı orta yaşlı yetişkinlerde kuvvet ile seçici dikkati ve inhibisyon cevabını içeren kognitif fonskiyonlar arasındaki ilişkinin incelemesidir. Çalışmaya 31 kadın ve 12 erkek dahil edildi (N=43, Yaş: 42.31± 9.76 yıl; Vücut ağırlığı: 71.42±14.85 kg; Boy uzunluğu: 162.33±7.96 cm). Katılımcılar; farklı günlerde kavrama kuvveti, 1 maksimum tekrar Bench press, 1 maksimum tekrar Leg press, 1 maksimum tekrar Long pulley, 1 maksimum tekrar Leg ekstansiyon, 1 maksimum tekrar overhead press and kognitif fonksiyonlar açısından test edildiler. Indirekt 1 maksimum tekrar değerleri Technogym Selection 900 marka ağırlık makinası ve formül vasıtasıyla belirlendi. Katılımcıların dominant taraf kavrama kuvvetleri dijital dinamometre kullanılarak belirlendi. Katılımcıların; seçici dikkatleri d2 testi ve inhibisyon cevapları ise bilgisayar temelli Go/No-Go testi ile belirlendi. Çoklu linear regresyon analizi, katılımcıların kavrama kuvvetleri, 1 maksimum tekrar bench press, 1 maksimum tekrar leg ektansiyon, 1 maksimum tekrar leg press, 1 maksimum tekrar long pulley ve 1 maksimum tekrar overhead press değerleri ile kognitif fonksiyon testleri arasında ilişki olmadığını gösterdi. Bu sonuçlara dayanılarak, sağlıklı orta yaşlı katılımcıların kuvvet düzeylerinin, kognitif fonksiyonların göstergesi olamayacağı söylenebilir. Sağlıklı orta yaşlı bireylerde, kuvvet düzeyi ile kognitif fonskiyonlar arasındaki ilişkinin açıklanabilmesi için daha büyük örneklem ile çalışmalara ihtiyaç duyulmaktadır.*

Anahtar Kelimeler: *1 Maksimum tekrar, kavrama kuvveti, dikkat, inhibisyon, regresyon analizi.*

Received: 11.06.2023 / Accepted: 04.09.2023 / Published: 20.10.2023

https://doi.org/10.22282/tojras.1312314

Citation: *Umut, C., Kurt, C. (2023). Investigation of the Relationship Between Cognitive Functions, Physical Activity and Strength in Healthy Middle-Aged Adults, The Online Journal of Recreation and Sports (TOJRAS), 12 (4), 528-538.*

INTRODUCTION

Executive functions in humans can be separated into three basic functions working memory, inhibition, and cognitive flexibility (Padilla, Pérez, & Andrés, 2014). Hillman, Weiss, Hagberg, and Hatfield (2002) conducted a study that suggested that as people age, both their motor and cognitive processes often slow down." Physical functions such as strength and walking speed have been recognized as indicators of overall health (Zammit, Robitaille, Piccinin, Muniz-Terrera, and Hofer, 2019).

In a longitudinal aging cohort study conducted by Clouston, Brewster, Kuh, Richards, Cooper, Hardy, and Hofer (2013), it was found that higher physical function was associated with better cognitive performance. Additionally, slow walking speed and declining hand-grip strength have been identified as early functional biomarkers of cognitive decline in individuals with mild cognitive impairment and dementia (Adamo, Anderson, Koochaki, and Fritz, 2020).

According to Ruegsegger and Booth (2018), physical activity has been reported as a non-invasive therapy that can contribute to improvements in mental health, cognition, depression, anxiety, drug addiction, and neurodegenerative diseases such as Alzheimer's and Parkinson's disease.

Muscular strength is indeed one of the health-related physical fitness components, as noted by Cattuzzo, dos Santos Henrique, Ré, de Oliveira, Melo, de Sousa Moura, and Stodden (2016). Various training programs and modalities have been recommended to maintain and improve strength in older adults, as highlighted by Chang, Pan, Chen, Tsai, and Huang (2012). These can include traditional strength training modalities such as calisthenic exercises, free weights and machines, as well as other devices like bands. Additionally, specific exercise training methods such as Taiji, Pilates, or yoga have also been suggested to enhance strength in older adults (Misic, Valentine, Rosengren, Woods, and Evans, 2009).

It is widely accepted that resistance training offers mental health benefits for adults, which include the reduction of symptoms in individuals with fatigue, anxiety, and depression. Additionally, resistance training has been shown to alleviate pain in individuals with conditions such as osteoarthritis, fibromyalgia, and low back issues. Moreover, resistance training has demonstrated improvements in cognitive abilities among older adults and enhancements in self-esteem (Smolarek, Ferreira, Mascarenhas, McAnulty, Varela, Dangui, and Souza-Junior, 2016; Westcott, 2012; Kimura, Obuchi, Arai, Nagasawa, Shiba, Watanabe, and Kojima, 2010).

The benefits of strength training can be attributed to its potential to improve various parameters, such as insulin sensitivity. Furthermore, strength training has been found to have positive effects on anti-inflammatory pathways and the brain-derived neurotrophic factor (BDNF) pathways, which are associated with sarcopenia (age-related muscle loss) and cognitive changes. This suggests that strength training may play a role in mitigating these conditions (Yoon, Kang, Kim H, Kim J, Song H, and Song W, 2017).

Hand-grip strength has indeed been widely accepted as an easy and inexpensive method for estimating overall muscle strength, and it is considered a powerful biomarker of aging (McGrath, Kraemer, Snih, and Peterson, 2018). There is evidence to suggest that decreased hand-grip strength is associated with lower scores in various cognitive domains, including executive function, attention, working memory, language, schematic categorization, and overall cognition in non-demented older adults (Guerrero-Berroa, Ravona-Springer, Heymann, Schmeidler, Silverman, Sano, and Beeri, 2014; Buchman, Boyle, Wilson, Tang, and Bennett, 2007).

Besides hand-grip strength, Frith and Loprinzi (2018) reported that elderly individuals with increased lower extremity strength demonstrated higher performance on a test of executive cognitive functioning and reduced their risk of having low cognitive function by 34%. However, Ohsugi, Murata, Kubo, Hachiya, Hirao, Fujiwara, and Kamijou (2014) suggest lower limb muscle strength in the elderly does not differ with cognitive decline. Alonso, Peterson, Busse, Jacob-Filho, Borges, Serra, and Greve (2016) also reported that lower strength during the plantar flexor was associated with poorer performance in cognitive functions, including perception and reaction time. While studies by Yang, Deng, Yan, Li, Wang, Liao, and Rong (2022), Adamo et al. (2020), Kim, Park, Lee, and Lee (2019), and Zammit et al. (2019) used hand-grip strength as a marker of general strength level, were unable to find any sufficient numbers of studies in the existing literature that examine the association between upper and/or lower body strength and cognitive functions

METHODS

Research Model: A quantitative research method was used in the study. According to the positivist understanding upon which quantitative research is based, knowledge is generally acquired through experimentation, observation, and the rules of reason. This type of knowledge is deductive. Scientific knowledge obtained through experimentation and observation, which demonstrates the invariant and universal relationship between phenomena, is accurate; it is generalizable, meaning it is universal. In a sense, this knowledge is reliable and valid according to the laws. Such knowledge can be expressed numerically and can be subjected to statistical analysis because, according to the positivist understanding, logic, and mathematics underlie all sciences (Sönmez and Alacapınar, 2013). The research design used in this study is causal-comparative research. Causal comparative research aims to determine the causes that affect the results of a past event. The researcher cannot intervene in the phenomenon, process, or results in any way. In other words, they cannot introduce any variables into the environment as in experimental methods. The phenomenon has already occurred and ended. The results are evident. Scientific activities should be employed to determine the cause(s) of these results (Büyüköztürk et al., 2014).

Purposes of the research: The purpose of this study was to investigate the relationship between strength, evaluated through hand-grip, 1RM bench press, 1RM leg press, 1RM long pulley, 1RM leg extension, and 1RM overhead press tests, and cognitive functions including selective attention and inhibitory response in healthy middle-aged adults. The study hypothesized that there would be an association between upper extremity strength, and lower extremity strength, as assessed by the hand-grip strength, 1RM bench press, 1RM long pulley, 1RM overhead press, 1RM leg press, and 1RM leg extension tests, respectively, and cognitive functions in middle-aged healthy adults.

Participants: Forty-three (43) healthy middle-aged adults, consisting of 12 men and 31 women, were recruited for this study. A comprehensive list of their characteristics is provided in Table 1. Prior to participation, the participants were fully informed about the study's procedures. After receiving the necessary information, each participant provided informed consent by signing a consent form. The study protocol was approved by the human subjects ethics committee of Tekirdağ Namık Kemal University (Protocol No: 2021.275.11.19.), and all procedures were conducted in accordance with the 1964 ethical guidelines of the Declaration of Helsinki. The inclusion criteria for participation in the study were being 18 years of age or older and the absence of any musculoskeletal injuries, cardiovascular diseases, or neurological abnormalities. Participants who were currently taking medication or had declared cognitive impairment were excluded from the study.

Data collection: The participants were informed about the assessments, and all measurements were completed over the course of two days. On the first day, demographic information such as age, sex, medical history (chronic health status number), smoking habits, and other characteristics were recorded. The short form of the International Physical Activity Questionnaire (IPAQ) was used to estimate the physical activity level of the participants, and this interview-administered questionnaire took approximately 10-15 minutes to complete. The participants' body height and body weight were measured, and their body mass index (BMI) was calculated using the formula BMI = kg/m2.

At the end of the measurements on the first day, the participants' hand-grip strength was primarily measured. Following that, the indirect 1RM (one-repetition maximum) force determination method was used to assess the participants' 1RM strength values for the bench press (kg), leg press (kg), long pulley (kg), leg extension (kg), and overhead press (kg) exercises. A 5-minute rest time was given to participants between 1 RM tests.

On the second day of the research, cognitive tests were conducted at least 48 hours after the first day.The participants completed the D2 attention test and the Go/No-Go tests, respectively. These cognitive tests were administered in a quiet setting with only the participant and the test administrator present, ensuring minimal distractions. The tests and measurements were conducted by the same researchers and in the same order for all participants.

Prior to the 1RM strength tests, the participants were allowed to perform a standard warm-up, which consisted of 10 minutes of jogging followed by 5 minutes of dynamic stretching. All tests were conducted at the same time of day (between 05:30 PM and 07:30 PM) to minimize the potential influence of circadian rhythms on the study results. After the completion of the tests, the participants were given adequate time to perform cool-down exercises.

The formula used to indirectly calculate 1 RM is below (Brzycki, 1993).

1 RM= (Lifted Weight) / [1,0278-(Repetition*0,0278)]

Measures

Measurement of the anthropometric characteristics: The participants' height and body weight were measured while they were barefoot. A portable height meter by Mesilife 13539 with a precision of 0.1 cm was used for height measurements. The individuals wore only shorts and T-shirts during the weight measurements, which were recorded using a precise Omron weighing system with an accuracy of 0.01 kg. The body mass index (BMI) was calculated using the formula where body mass (in kg) is divided by the square of body height (in m2).

The determination of physical activity: The study utilized the short form of the International Physical Activity Questionnaire (IPAQ-SF) to assess the participants' levels of physical activity. The questionnaire was administered to individuals aged 15 to 65 in order to gather information about their physical activity habits and behaviors. (Craig, Marshall, Sjöström, Bauman, Booth, Ainsworth, and Oja 2003). Tests of Turkish validity and reliability have previously been performed by Saglam, Arikan, Savci, Inal-Ince, Bosnak-Guclu, Karabulut, and Tokgozoglu (2010). The IPAQ measurement, which advices engaging in physical activity for at least 10 minutes at a time, was used in the study. The questionnaire asked individuals about the amount of time they spent participating in vigorous exercise, moderate exercise, walking, and sitting throughout the day. To convert the durations of walking and intense, moderate physical activity into the corresponding metabolic equivalent (MET) units, the following formula was employed: MET value = duration (minutes) × MET level. In this formula, 1 MET is equivalent to 3.5 ml/kg/min. The overall physical activity score (expressed as MET minutes per week) was then calculated by summing the MET values for each activity and multiplying by the corresponding duration. In the calculation of the MET values of the subjects the study by Maddision et al. (2007) was referred.

Hand-grip strength: The strength of the hand and forearm muscles was assessed using a handg-rip dynamometer, and the measurements were recorded in kilograms. The test was conducted with the subjects in a standing position, with their elbow fully extended and forearms in a neutral position. Three measurements were taken on the dominant side of each participant, with a 1-minute interval between each measurement.

During the test, the participants were instructed to grip the hand-grip dynamometer with maximum strength for a duration of 3 seconds, as recommended by Roberts, Denison, Martin, Patel, Syddall, Cooper, and Sayer, (2011). The highest score obtained from the three measurements was selected for further statistical analysis.

The strength of the hand and forearm muscles was measured (in kilograms) using a hand-grip dynamometer. The test was performed with the subjects standing position. The test was performed with a fully extended elbow and neutral forearm position. Three measurements were taken on the dominant side of the subjects with 1 min intervals. The participant was instructed to hand-grip the device with maximum strength for 3 s (Roberts, Denison, Martin, Patel, Syddall, Cooper, and Sayer, 2011) The highest scores of three measurements were taken for statistical analysis.

Determination of indirect 1 Repetition Maximum: The test is considered to be relatively simple, efficient, economical, and safe when it is used and administered correctly. By using appropriate calculations, the maximum number of repetitions performed with a given weight, ranging from 2 to 20, can be used to indirectly estimate the 1 repetition maximum (1 RM) value. The formulas used for calculating the 1 RM take into account the number of repetitions performed, allowing for variations below 20, and consider the relationship between the percentages of the 1 RM value, which can be either linear or curved.

It was determined that directly assessing the 1 RM value would pose potential risks and harm, particularly because the research participants in this study are adolescents who may not possess sufficient experience or training in proper strength training techniques. Therefore, the indirect method of estimating the 1 RM value was chosen to ensure the safety and well-being of the participants (Gearhart, Randall, Steven, Kristen, Ryan, and Robert, 2011).

Therefore, the 1 repetition maximum (1 RM) values for the bench press, leg press, long pulley, leg extension, and overhead press exercises were calculated using indirect methods. The participants began the session with a warm-up, using the lifting technique that would be used to determine the 1 RM indirectly. After the warm-up, a 1-5 minute break was provided. Then, the weight was gradually increased while the participants continued lifting with limited repetitions. The weight at which the participants could perform the exercise for the maximum number of repetitions (10 repetitions) was determined as their estimated 1 RM value (Ozer, 2017). The 1RM tests were conducted utilizing the Technogym Selection 900 weight machine.

Measurement of attention: The D2 attention test was used to assess the participant's attention span. The D2 test is a reliable technique for measuring levels of focus and selective attention. The participant's personal information, test results, and a trial row were recorded on the front page of the test. The actual test form consisted of 14 rows, each containing 47 marked letters. Each row included 16 different letters, comprising of "p" and "d" letters, with varying numbers of tiny markings (one, two, three, or four). To pass the test, the participant had to scan the rows within a time limit of 20 seconds per row, while disregarding irrelevant letters. The goal was to identify the "d" letters marked with a two and cross them out. Several measures were used to analyze the test results. The Total Matter Score Processed (TM) provided a quantitative evaluation of performance, encompassing both relevant and irrelevant items. The total error (E) included unmarked letters (E1) and incorrectly marked letters (E2). The Error Percentage (E%) measured the rate of mistakes made in processing all items, indicating the qualitative aspect of performance. Decreasing error rates were associated with higher accuracy, job proficiency, and attention span. Concentration performance (CP) was calculated by subtracting the E2 score from the number of accurately identified targets. The frequency rate (FR) represented the difference between the maximum and minimum numbers of processed items. The Total Matter-Error (TM-E) score was obtained by subtracting the error score from the total number of reviewed items. The TM-E score, which reflected overall performance, was a reliable measure that demonstrated the relationship between accuracy and processing speed. The resulting TM-E scores were divided into percentile intervals for interpretation. Scores below 50% were considered poor, while scores over 85% were considered average. Scores between 60% and 70% fell within the mediocre range.

Measurement of Inhibition: The Go/No-Go Task specifically focuses on assessing response inhibition, without involving any other cognitive processes (Farah, 2003). There are various versions of this task, but it has not yet been standardized in Turkey. In this study, a computer-based Go/No-Go task was utilized. The task employed images of X and O as stimuli. The O image served as the non-target stimulus, while the X image represented the target stimulus (Go/No-Go). The participant's objective was to resist the impulse to click the left mouse button when the non-target stimulus appeared, while quickly pressing the button when the target stimulus was presented. A total of 200 stimuli were used in the task, with 100 (50%) being non-target (No-Go) stimuli and 100 (50%) being target stimuli (Go). Each stimulus, whether target or non-target, was displayed on the screen for a duration of 50 milliseconds (stimulus duration). Following the presentation of these stimuli, a black screen was shown for 1,450 milliseconds (SOA). Therefore, there was a 1,500-millisecond interval between the beginning of one stimulus and the beginning of the next stimulus. The inter-stimulus intervals (ISI) were also 1,450 milliseconds long. Completing the task typically took approximately 5 minutes and 40 seconds. In the Go task, the accuracy score was determined based on the number of correct responses made by clicking the left mouse button in response to the target stimuli. The error score was determined by the number of times a response was not given to a target stimulus. The average reaction time for correct responses to target stimuli determined the accuracy in terms of reaction latency. In the No-Go task, the accuracy score represented the percentage of times a response was successfully withheld when a non-target stimulus was presented. The error score represented the percentage of times a response was mistakenly given by clicking the left mouse button on the non-target stimulus. The average reaction time for correct responses to target stimuli served as the measure of reaction latency in terms of errors.

Statistical analysis: The statistical analyses in this study were performed using SPSS software (version 18, IBM Corporation, New York, United States), with statistical significance set at $p < 0.05$. Descriptive statistics, including means and standard deviations (M ± SD) for continuous data and percentages for categorical data, were used to summarize participant characteristics. The normality of outcome variables was assessed using the Kolmogorov-Smirnov test, histograms, and normal quantile-quantile (Q-Q) plots. Partial correlation analysis was used to analyze the correlation between components of cognitive functions, Physical activity level (PAL), and strength parameters while controlling for age, sex, and BMI. The partial correlation coefficient was categorized as small (0-0.30), moderate (0.31-0.49), large (0.50-0.69), very large (0.70-0.89), or almost perfect (0.90-1.00) (Cavedon, Bezodis, Sandri, Pirlo, Zancanaro, and Milanese, 2022). Multiple linear regression models (hierarchical regression) estimated by ordinary least squares (OLS) were used to assess the relative contribution of PAL and strength parameters as predictors of attention and inhibition and the specific contribution of the components of PAL and strength parameters to the components of attention and inhibition, while controlling for age, sex, and BMI (Cook, Howard, Scerif, Twine, Kahn, Norris, and Draper, 2019). One of the conditions required for hierarchical regression analysis is that there is no high degree of correlation (multicollinearity) between predictor variables. This was checked by looking at Variance Inflation Factors (VIF) or Tolerance Values (Tolerance = 1/VIF), which represent the proportion of variance in an independent variable that is not explained by the other independent variables. It has been reported that there is no problem with correlation when the largest VIF value is less than 10 and the Tolerance value is greater than 0.2 (Field, 2005). It was determined that the obtained data met this condition. Another requirement for multiple linear regression analysis to yield accurate results is that the differences between predicted and observed values (prediction errors) should follow a normal distribution. To ensure this, a scatter plot was drawn with standardized predicted values (Z-Predicted) on the x-axis and standardized residuals (Z-Residuals) on the y-axis. If the points scatter randomly around 0, it indicates that the error follows a normal distribution and that the variance of residuals can be assumed to be constant (Field, 2005). At this point, it was determined that the research data also met this condition.

RESULTS

Table 1 presents the mean, standard deviation, and percentage values for the variables in detail. No significant relationship was found in the prediction of the inhibition parameters GCR and GCRL, GCR Model 1: ($F(3-39)=0.531$, $p=0.664$); GCR Model 2: ($F(10-32)=0.902$, $p=0.542$); GCRL Model 1: ($F(3-39)=0.705$, $p=0.555$); GCRL Model 2: ($F(10-32)=0.530$, $p=0.856$) (Table 2). Similarly, the results of the hierarchical regression analysis performed to determine how the attention parameters are predicted by age, gender and BMI, in addition PAL and Strength parameters, show that there is no significant relationship between the TM and E1 parameters and the attention parameters. Specifically, there is no significant relationship found in either the prediction of the TM parameter with TM Model 1: ($F(3-39)=1.206$, $p=0.320$); TM Model 2: ($F(10-32)=0.717$, $p=0.702$); E1 Model 1: ($F(3-39)=1.940$, $p=0.139$); E1 Model 2: ($F(10-32)=1.350$, $p=0.247$) (Table 3).

Table 1. Descriptive statistics of study variables

Variables	M ± SD / %
Demographics	
Age (years)	42.31±9.76
Gender (31 Female and 12 Male)	% 72.09 / % 21.81
Height (cm)	162.33±7.96
Body mass (kg)	71.42±14.85
BMI (kg/m^2)	27.05±5.14
PAL	740.58±700.67
Strength parameters	
Hand-grip strength (kg)	34.16±7.36
1RM bench press (kg)	32.59±16.54
1RM leg press (kg)	93.44±55.19
1RM long pulley (kg)	35.39±13.49
1RM leg extension (kg)	47.98±22.90
1RM overhead press (kg)	25.46±11.64
Inhibition parameters	
GCR (n)	94.48±5.09
GCRL (ms)	240.44±77.86
Attention parameters	
TN	514.27±89±89
E1	123.20±50.26

GCR: number of correct responses in the Go task; GCRL: correct response latency in the Go task; TN: Total number of matters processed (Representing participants' psychomotor speed); E1: Nonmarked letters (Representing the selective attention of the participants); PAL= Physical activity level; n: number; ms: millisecond; M: Mean; SD: Standard deviation

Table 2: The multiple linear regression analysis outcomes of PA and strength parameters predicting performance on inhibition.

CR	Predictors	B	SE	β	t	p	R^2	Adj.R^2
Model 1	Age	0.042	0.082	0.081	0.514	0.610	0.039	-0.035
	Sex[a]	-0.658	1.839	-0.059	-0.358	0.723		
	BMI	0.151	0.162	0.152	0.928	0.359		
Model 2	Age	-0.026	0.094	-0.050	-0.277	0.783	0.220	-0.024
	Sex[a]	-4.434	3.879	-0.395	-1.143	0.262		
	BMI	0.275	0.202	0.278	1.362	0.183		
	PAL	0.001	0.002	0.087	0.414	0.682		
	Hand-grip strength	0.407	0.231	0.588	1.761	0.088		
	1RM bench press	-0.216	0.129	-0.702	-1.672	0.104		
	1RM leg press	-0.007	0.024	-0.077	-0.295	0.770		
	1RM long pulley	0.035	0.081	0.092	0.427	0.672		
	1RM leg extension	0.014	0.077	0.063	0.182	0.857		
	1RM overhead press	-0.156	0.166	-0.358	-0.942	0.353		
GCRL								
Model 1	Age	1.013	1.254	0.127	0.808	0.424	0.227	0.051
	Sex[a]	15.161	27.943	0.088	0.543	0.591		
	BMI	-2.227	2.467	-0.147	-0.903	0.372		
Model 2	Age	0.816	1.500	0.102	0.544	0.590	0.377	0.142
	Sex[a]	-6.244	62.217	-0.036	-0.100	0.921		
	BMI	-2.818	3.239	-0.186	-0.870	0.391		
	PAL	-0.023	0.025	-0.208	-0.944	0.352		
	Hand-grip strength	-1.686	3.702	-0.159	-0.456	0.652		
	1RM bench press	-0.957	2.073	-0.203	-0.462	0.647		
	1RM leg press	-0.386	0.385	-0.274	-1.002	0.324		
	1RM long pulley	1.145	1.306	0.199	0.877	0.387		
	1RM leg extension	1.632	1.237	0.480	1.319	0.196		
	1RM overhead press	-0.953	2.662	-0.143	-0.358	0.723		

a0 = men; 1 = women, SE = Std. Error; GCR Model 1: (F(3-39)=0.531, p=0.664); GCR Model 2: (F(10-32)=0.902, p=0.542); GCRL Model 1: (F(3-39)=0.705, p=0.555); GCRL Model 2: (F(10-32)=0.530, p=0.856)

Partial correlation was conducted by adjusting for age, gender and BMI. No relationship was found between the participants' GCR and PAL, hand-grip strength and 1 RM strength parameters (p>0.05) (Figure 1). There was no relationship between the participants' GCRL and PAL, hand-grip strength and 1 RM strength parameters (p>0.05) (Figure 2). No relationship was found between PAL, hand-grip strength and 1 RM strength parameters (p>0.05) (Figure 3). A weak positive correlation was found between the participants' E1 parameter and 1 RM leg extension parameter (r = 0.342; p<0.05). No relation of E1 parameter with other variables was determined (p>0.05) (Figure 4).

Table 3. The multiple linear regression analysis outcomes of PA and strength parameters predicting performance on attention

TM	Predictors	B	SE	β	t	p	R^2	Adj.R^2
Model 1	Age	-2.213	1.422	-0.240	-1.557	0.128	0.291	0.085
	Sex[a]	27.638	31.686	0.140	0.872	0.388		
	BMI	-1.212	2.797	-0.069	-0.433	0.667		
Model 2	Age	-2.184	1.690	-0.237	-1.292	0.206	0.428	0.183
	Sex[a]	-3.983	70.086	-0.020	-0.057	0.955		
	BMI	-1.229	3.649	-0.070	-0.337	0.738		
	PAL	-0.013	0.028	-0.102	-0.473	0.640		
	Hand-grip strength	1.376	4.170	0.113	0.330	0.744		
	1RM bench press	-0.603	2.336	-0.111	-0.258	0.798		
	1RM leg press	0.352	0.434	0.216	0.811	0.423		
	1RM long pulley	-0.122	1.471	-0.018	-0.083	0.934		
	1RM leg extension	-0.576	1.394	-0.147	-0.413	0.682		
	1RM overhead press	-2.028	2.999	-0.263	-0.676	0.504		
E1								
Model 1	Age	1.594	0.775	0.310	2.057	0.046	0.130	0.063
	Sex[a]	16.693	17.276	0.151	0.966	0.340		
	BMI	-0.500	1.525	-0.051	-0.328	0.745		
Model 2	Age	1.811	0.877	0.352	2.065	0.047	0.297	0.077
	Sex[a]	27.641	36.359	0.250	0.760	0.453		
	BMI	-1.498	1.893	-0.153	-0.791	0.434		
	PAL	-0.013	0.014	-0.181	-0.904	0.373		
	Hand-grip strength	-0.069	2.163	-0.010	-0.032	0.975		
	1RM bench press	-0.092	1.212	-0.030	-0.076	0.940		
	1RM leg press	-0.118	0.225	-0.129	-0.522	0.605		
	1RM long pulley	-0.872	0.763	-0.234	-1.143	0.262		
	1RM leg extension	1.453	0.723	0.662	2.010	0.053		
	1RM overhead press	-0.359	1.556	-0.083	-0.231	0.819		

a0 = men; 1 = women, SE = Std. Error; TM Model 1: (F(3-39)=1.206, p=0.320); TM Model 2: (F(10-32)=0.717, p=0.702); E1 Model 1: (F(3-39)=1.940, p=0.139); E1 Model 2: (F(10-32)=1.350, p=0.247

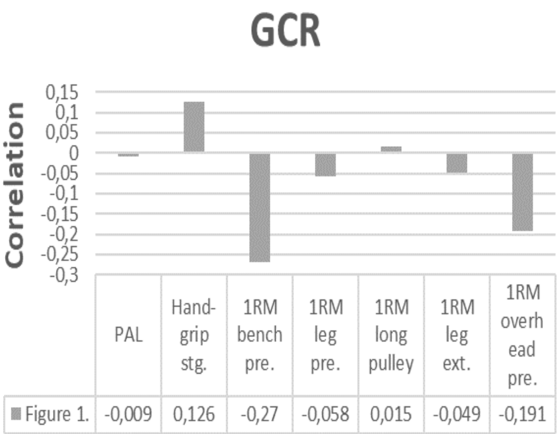

Figure 1. The relationship between the participants' GCR and PAL, hand-grip strength and 1 RM strength parameters.

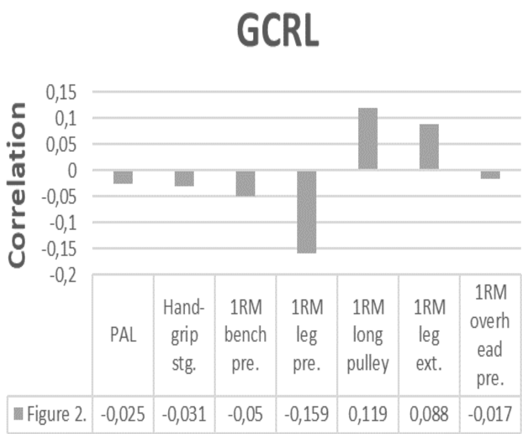

Figure 2. The relationship between the participants' GCRL and PAL, hand-grip strength and 1 RM strength parameters.

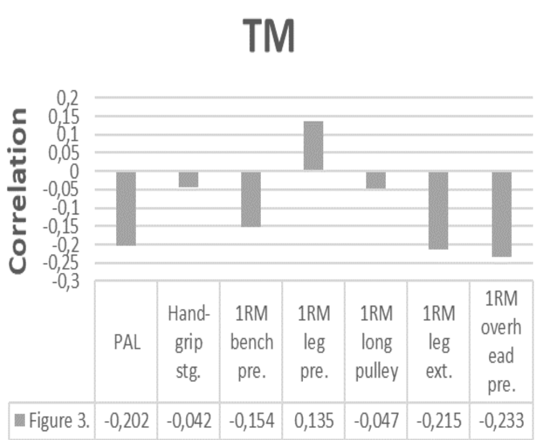

Figure 3. The relationship between the participants' TM and PAL, hand-grip strength and 1 RM strength parameters

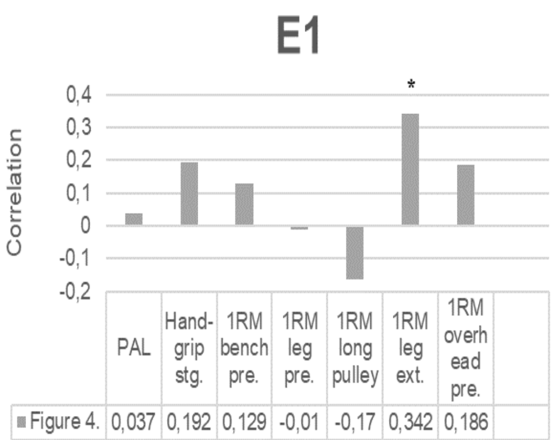

Figure 4. The relationship between the participants' E1 and PAL, hand-grip strength and 1 RM strength parameters.

DISCUSSION

The aim of this study was to examine the potential correlation between different measures of strength, such as hand-grip strength, as well as 1RM values for bench press, leg press, long pulley, leg extension, and overhead press, with cognitive functions related to selective attention and inhibitory response in healthy middle-aged adults. The main findings of the study suggest that there was no significant correlation between the various strength tests (hand-grip strength, 1RM bench press, 1RM long pulley, 1RM overhead press, 1RM leg press, and 1RM leg extension) and cognitive functions related to selective attention and inhibitory response in healthy middle-aged adults. However, a weak positive correlation was observed between the participants' selective attention (E1 parameter) and the 1RM leg extension parameter. Based on the results of the study, which showed no significant correlation between the strength tests and cognitive functions except for a weak positive correlation between selective attention and 1RM leg extension, it can be concluded that the hypothesis of the study was not refuted. The hypothesis proposed a potential association between strength measures and cognitive functions, but the findings did not provide strong evidence to support this hypothesis. Therefore, it is suggested that other factors or variables might play a more significant role in determining cognitive functions in healthy middle-aged adults.

Most of the studies regarding the interaction between strength and cognitive function reported that significant association (Yang et al.,2022; Adamo et al.,2020; Kim et al.,2019; Zammit et al.,2019), However, all of these studies age of participants was older than 65 years (Yang et al.,2022; Adamo et al.,2020; Kim et al.,2019; Zammit et al.,2019). In our study, the age of participants was 42.31±9.76 years. Adamo et al (2020) reported that hand-grip strength does not an indicator of the cognitive function of participants younger than 65. It is greatly likely that inconsistent results obtained from relevant literature and our study may be caused by participants' age.

During the literature review, we realized that only a few studies have been aimed to explain the association between lower extremities, and cognitive functions (Frith and Loprinzi (2018), Ohsugi et al.,2014 , and Alonso et al (2016). Studies by Frith and Loprinzi (2018) and Alonso et al (2016), reported that lower extremity strength is strongly associated with cognitive functions. However, the study by Ohsugi et al.,2014 has shared similar results with the results of our study. Ohsugi et al.,2014 argued the lower limb muscle strength of the elderly does not differ with cognitive decline. The study by Ohsugi et al.,2014 Isometric knee extension strength (IKES) has been evaluated by a hand-held dynamometer [HHD].

In the study by Alonso et al. (2016), the strength of the plantar flexor muscles in the lower limbs was measured using an isokinetic dynamometer. With regards to the study by Frith and Loprinzi (2018), they have used a Kin-Com MP isokinetic dynamometer to assess lower extremity strength. However, in our study, lower extremity strength was evaluated by 1RM test through leg press and leg extension machine. It has been considered that Isokinetic muscle testing is a reliable and valid instrument for muscle force testing and is often used as a reference standard to compare other instruments of measurement that test muscle strength (Stark, Walker, Phillips, Fejer, and Beck, 2011). Inconsistent results between our study and the given literature might be caused by strength tests, test machines, and targeted muscle groups. When considering the age factor and its potential influence on strength test results, the findings of Alonso et al. (2016) suggest that age-related changes in physical function and cognition can significantly impact the ability to perform crucial driving tasks. Therefore, both the strength test results from previous literature and our study may be influenced by the age of the participants. The participants in the study conducted by Alonso et al. (2016) had an average age of 70.4 ± 5.8 years. Similarly, the participants in the study by Frith and Loprinzi (2018) ranged in age from 60 to 85 years. Additionally, the participants in the study by Ohsugi et al. (2014) had an average age of 73.6 ± 6.6 years. In comparison, the participants in our study had a relatively younger age of 42.31 ± 9.76 years. It is important to note that the age difference between the studies may contribute to variations in strength test results and their associations with cognitive functions.

One of the aims of this study was to explore the association between upper body strength and cognitive functions by employing various tests, such as the 1RM bench press, long pulley, 1RM overhead press, and hand-grip tests. However, the study did not find any significant association between upper body strength, as measured by these tests (1RM bench press, long pulley, 1RM overhead press, and hand-grip tests), and cognitive functions such as selective attention and inhibitory response in healthy middle-aged adults. It is worth noting that, to the best of our knowledge, there are no existing studies that have specifically examined the association between upper body strength and cognitive functions using the 1RM bench press, long pulley, 1RM overhead press, and hand-grip tests mentioned in this study. Therefore, this study provides valuable insights into this unexplored area of research. Therefore, this study might be among the first to investigate the relationship between upper body strength, as measured by the 1RM bench press, long pulley, and 1RM overhead press tests, and cognitive functions. However, it is important to note that further research is necessary to expand our understanding in this area. Future studies could consider larger sample sizes and explore different measures of cognitive performance to provide a more comprehensive understanding of the association between upper body strength and cognitive functions.

Another result obtained in the current study is a weak positive correlation between the participants' selective attention (E1 parameter) and the 1RM leg extension parameter. Stevens and Bavalier (2012) described selective attention as "selective attention refers to the processes that allow an individual to select and focus on particular input for further processing while simultaneously suppressing irrelevant or distracting information" Selective attention is an important cognitive function implicated in a variety of daily living activities (Alves, Tessaro, Teixeira, Murakava, Roschel, Gualano, and Takito, 2014). A study by Alves et al (2014) reported that moderate-intensity continuous aerobic exercise can promote a beneficial effect on speed processing, selective attention, and aspects of inhibitory control. Alves, Gualano, Takao, Avakian, Fernandes, Morine, and Takito (2012) also reported that both acute aerobic and strength training equally improved selected executive functions (i.e., selective attention and susceptibility to interference) in middle-aged women. Wengaard, Kristoffersen, Harris, and Gundersen (2017) reported that cardiorespiratory fitness is associated with cognitive performance in healthy male high-school students (17.9 ± 0.9 years) in the executive domains of selective attention. Filardi, Barone, Bramato, Nigro, Tafuri, Frisullo, and Logroscino (2022) argued that in mild cognitive impairment and Alzheimer's disease, hand-grip strength was associated with overall cognitive functioning, and attentional and memory performance. However, we could not reach any study apart from studies by Ohsugi et al (2014) that have aimed to examine the association between strength and attention by using different strength tests except for the hand-grip strength test as in our study.

The 30-Second Chair Stand Test (30CST) assesses the number of times a person can stand than sit in a chair in 30 seconds (Unver, Kahraman, Kalkan, Yuksel, Karatosun, and Gunal,2015). The 30CST is a popular method of assessing lower limb muscle strength in a clinical setting (Góes, Leite, Shay, Homann, Stefanello, and Rodacki,2012) and Ohsugi et al (2014a) argued that a strong correlation between 30CST and isometric knee extension strength. Ohsugi et al (2014) reported that no association between the 30CST score and cognitive functions including attention. However, a different study by Ohsugi et al. (2014) suggested that there may be gender differences in the relationship between lower extremity function and cognitive function, particularly in female participants. This study found that cognitive decline was associated with poor lower extremity function, as evaluated by the 30CST, in females. These findings indicate that further studies are needed to fully understand the association between strength, including lower extremity strength, and cognitive functions in healthy middle-aged adults. Additional research is necessary to explore the potential gender differences and provide a more comprehensive understanding of this relationship.

The study has two main limitations. Firstly, the sample size of the study is relatively small, which may limit the generalizability of the findings. Replication of the study with a larger and more diverse sample is recommended to validate the results and obtain a more comprehensive understanding of the relationship between strength and cognitive functions. Secondly, it is important to note that the participants recruited for the study were middle-aged adults. Cognitive decline typically starts to become more prominent in individuals aged 60 and above. Conducting a similar study with older individuals could provide insights into potential age-related changes and yield different results regarding the association between strength and cognitive functions. Mixing gender in the sample of the study or not having an equal number of female and male participants might be additional limitations of the study. Therefore, future research involving a larger sample size, an equal number of female and male participants, and a broader age range is needed to further explore this relationship.

Conclusion: We found no significant association between strength and cognitive functions in healthy middle-aged adults. To further explore the relationship between strength and cognitive functions in this population, future research with a larger sample size is needed. Although the results of this study did not demonstrate a direct relationship, it is noteworthy that different strength tests for both the upper and lower extremities, excluding the hand-grip test, were utilized. This approach provides valuable insights into potential variations in the impact of different muscle groups on cognitive functions in middle-aged adults

Ethical clearance: *The research and publication process adhered to journal publication rules, principles, and research and publication ethics. Authors are responsible for any kind of ethical violation concerning the article. The study procedure was approved by the Human Subjects Ethics Committee of Tekirdağ Namık Kemal University (Protocol No: 2021.275.11.19.)*

Conflict of interest: *No conflict of interest has been declared regarding the article.*

The authors' contribution rates: *The contribution rates of the authors are as follows: the first author contributed 50%, the second author contributed 30%, and the third author contributed 20%.*

References

Adamo, D. E., Anderson, T., Koochaki, M., & Fritz, N. E. (2020). Declines in grip strength may indicate early changes in cognition in healthy middle-aged adults. PLoS One, 15(4), e0232021.

Alonso, A. C., Peterson, M. D., Busse, A. L., Jacob-Filho, W., Borges, M. T., Serra, M. M., ... & Greve, J. M. (2016). Muscle strength, postural balance, and cognition are associated with braking time during driving in older adults. Experimental gerontology, 85, 13-17.

Alves, C. R. R., Gualano, B., Takao, P. P., Avakian, P., Fernandes, R. M., Morine, D., & Takito, M. Y. (2012). Effects of acute physical exercise on executive functions: a comparison between aerobic and strength exercise. Journal of Sport and Exercise Psychology, 34(4), 539-549.

Alves, C. R., Tessaro, V. H., Teixeira, L. A., Murakava, K., Roschel, H., Gualano, B., & Takito, M. Y. (2014). Influence of acute high-intensity aerobic interval exercise bout on selective attention and short-term memory tasks. Perceptual and motor skills, 118(1), 63-72.

Brickenkamp, R., & Zillmer, E. (1998). The d2 test of attention. Seattle: Hogrefe & Huber Publishers.

Buchman, A. S., Boyle, P. A., Wilson, R. S., Tang, Y., & Bennett, D. A. (2007). Frailty is associated with incident Alzheimer’s disease and cognitive decline in the elderly. Psychosomatic medicine, 69(5), 483-489.

Buyukozturk, Ş., Kilic Cakmak, E., Akgun, Ö.E., Karadeniz, Ş. and Demirel, F. (2014). Scientific research methods. 16th Edition. Ankara: Pegem Academy.

Brzycki, M. (1993) Strength testing-Predicting a one-rep max from reps-to-fatigue. JOPERD, 68, p. 88-90

Cattuzzo, dos Santos Henrique, Ré, de Oliveira, Melo, de Sousa Moura, & Stodden, D. (2016). Motor competence and health-related physical fitness in youth: A systematic review. Journal of science and medicine in sport, 19(2), 123-129

Cavedon, V., Bezodis, N. E., Sandri, M., Pirlo, M., Zancanaro, C., and Milanese, C. (2022). Relationships between anthropometric characteristics, block settings, and block clearance technique during the sprint start. J. Sports Sci. 40, 1097–1109. doi: 10.1080/02640414.2022.2049082

Chang, Y.K., Pan, C.Y., Chen, F.T., Tsai, C.L., & Huang, C. C. (2012). Effect of resistance-exercise training on cognitive function in healthy older adults: a review. Journal of aging and physical activity, 20(4), 497-517.

Clouston, S.A., Brewster, P., Kuh, D., Richards, M., Cooper, R., Hardy, R., ... & Hofer, S.M. (2013). The dynamic relationship between physical function and cognition in longitudinal aging cohorts. Epidemiologic reviews, 35(1), 33-50.

Craig, C.L., Marshall, A.L., Sjöström, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., & Oja, P. International physical activity questionnaire: 12-country reliability and validity. MSSE 2003, 35, 1381-1395. https://doi 10.1249/01.mss.0000078924.61453.fb

Cook, C.J., Howard, S.J., Scerif, G., Twine, R., Kahn, K., Norris, S.A. & Draper, C.E. Associations of physical activity and gross motor skills with executive function in preschool children from low-income South African settings. Dev. Sci 2019, 22, e12820. https://doi: 10.1111/desc.12820

Farah, M. (2003). Frontal lobes: Cognitive neuropsychological issues. In E. T. Feinberg & J. M. Farah (Eds.), Behavioural neurology & neuropsychology (pp. 393-399). New York: McGraw Hill.

Field, A. Discovering Statistics Using SPSS. Sage Publication: London, 2005

Filardi, M., Barone, R., Bramato, G., Nigro, S., Tafuri, B., Frisullo, M. E., ... & Logroscino, G. (2022). The relationship between muscle strength and cognitive performance across Alzheimer's disease clinical continuum. Frontiers in Neurology, 13.

Frith, E., & Loprinzi, P.D. (2018). The association between lower extremity muscular strength and cognitive function in a national sample of older adults. Journal of lifestyle medicine, 8(2), 99.

Gearhart Jr, Randall F., Steven E. Riechman, Kristen M. Lagally, Ryan D. Andrews, & Robert J. Robertson. (2011). "Safety of using the adult OMNI Resistance Exercise Scale to determine 1-RM in older men and women." Perceptual and motor skills, 113 (2), 671-676.

Góes, S.M., Leite, N., Shay, B.L., Homann, D., Stefanello, J.M., & Rodacki, A.L. (2012). Functional capacity, muscle strength and falls in women with fibromyalgia. Clinical Biomechanics, 27(6), 578-583.

Guerrero-Berroa, E., Ravona-Springer, R., Heymann, A., Schmeidler, J., Silverman, J. M., Sano, M., ... & Beeri, M. S. (2014). Decreased motor function is associated with poorer cognitive function in elderly with type 2 diabetes. Dementia and geriatric cognitive disorders extra, 4(1), 103-112.

Hillman, C.H., Weiss, E.P., Hagberg, J.M., & Hatfield, B.D. (2002). The relationship of age and cardiovascular fitness to cognitive and motor processes. Psychophysiology, 39(3), 303-312.

Kim, K.H., Park, S.K., Lee, D.R., & Lee, J. (2019). The relationship between handgrip strength and cognitive function in elderly Koreans over 8 years: a prospective population-based study using Korean longitudinal study of ageing. Korean journal of family medicine, 40(1), 9.

Kimura, K., Obuchi, S., Arai, T., Nagasawa, H., Shiba, Y., Watanabe, S., & Kojima, M. (2010). The influence of short-term strength training on health-related quality of life and executive cognitive function. Journal of physiological anthropology, 29(3), 95-101.

Maddison, R., Ni Mhurchu, C., Jiang, Y., Vander Hoorn, S., Rodgers, A., Lawes, C. M., & Rush, E. (2007). International physical activity questionnaire (IPAQ) and New Zealand physical activity questionnaire (NZPAQ): a doubly labelled water validation. International Journal of Behavioral Nutrition and Physical Activity, 4(1), 1-9.

Misic, M.M., Valentine, R.J., Rosengren, K.S., Woods, J.A., & Evans, E.M. (2009). Impact of training modality on strength and physical function in older adults. Gerontology, 55(4), 411-416.

McGrath, R.P., Kraemer, W.J., Snih, S.A., & Peterson, M.D. (2018). Handgrip strength and health in aging adults. Sports medicine, 48, 1993-2000.

Ohsugi, H., Murata, S., Kubo, A., Hachiya, M., Hirao, A., Fujiwara, K., & Kamijou, K. (2014a). Verification of the correlation between cognitive function and lower limb muscle strength for the community-dwelling elderly. Journal of physical therapy science, 26(12), 1861-1863.

Ozer M.K. (2017). Muscle strength. https://kamilozer.com/wpcontent/uploads/2017/09/Kuvvet.pdf. [Retrieved: 03.04.2022].

Padilla, C., Pérez, L., & Andrés, P. (2014). Chronic exercise keeps working memory and inhibitory capacities fit. Frontiers in behavioral neuroscience, 8, 49.

Roberts, H.C., Denison, H.J., Martin, H.J., Patel, H.P., Syddall, H., Cooper, C., & Sayer, A. A. (2011). A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardized approach. Age and ageing, 40(4), 423-429

Ruegsegger, G. N., & Booth, F. W. (2018). Health benefits of exercise. Cold Spring Harbor perspectives in medicine, 8(7), a029694.

Saglam, M., Arikan, H., Savci, S., Inal-Ince, D., Bosnak-Guclu, M., Karabulut, E., & Tokgozoglu, L. International physical activity questionnaire: reliability and validity of the Turkish version. Percept Mot Skills, 2010, 111, 278-284. https://doi: 10.2466/06.08.PMS.111.4.278-284.

Smolarek, A.D.C., Ferreira, L. H. B., Mascarenhas, L. P. G., McAnulty, S. R., Varela, K. D., Dangui, M. C., ... & Souza-Junior, T. P. (2016). The effects of strength training on cognitive performance in elderly women. Clinical interventions in aging, 749-754.

Sonmez, V., & Alacapınar, F. G. (2013). Illustrated scientific research methods. Anı Publishing.

Spreen, O., & Strauss, E. (1998). A compendium of neuropsychological tests. New York: Oxford University Press.

Stark, T., Walker, B., Phillips, J.K., Fejer, R., & Beck, R. (2011). Hand-held dynamometry correlation with the gold standard isokinetic dynamometry: a systematic review. PM&R, 3(5), 472-479

Stevens, C., & Bavelier, D. (2012). The role of selective attention on academic foundations: A cognitive neuroscience perspective. Developmental cognitive neuroscience, 2, S30-S48.

Unver, B., Kahraman, T., Kalkan, S., Yuksel, E., Karatosun, V., & Gunal, I. (2015). Test-retest reliability of the 50-foot timed walk and 30-second chair stand test in patients with total hip arthroplasty. Acta Orthop Belg, 81(3), 435-41.

Wengaard, E., Kristoffersen, M., Harris, A., & Gundersen, H. (2017). Cardiorespiratory fitness is associated with selective attention in healthy male high-school students. Frontiers in human neuroscience, 11, 330.

Westcott, W.L. (2012). Resistance training is medicine: effects of strength training on health. Current sports medicine reports, 11(4), 209-216.

Yang, J., Deng, Y., Yan, H., Li, B., Wang, Z., Liao, J., ... & Rong, S. (2022). Association Between Grip Strength and Cognitive Function in US Older Adults of NHANES 2011–2014. Journal of Alzheimer's Disease, (Preprint), 1-10.

Yoon, D. H., Kang, D., Kim, H. J., Kim, J. S., Song, H. S., & Song, W. (2017). Effect of elastic band-based high-speed power training on cognitive function, physical performance and muscle strength in older women with mild cognitive impairment. Geriatrics & gerontology international, 17(5), 765-772.

Zammit, A.R., Robitaille, A., Piccinin, A.M., Muniz-Terrera, G., & Hofer, S.M. (2019). Associations between aging-related changes in grip strength and cognitive function in older adults: a systematic review. The Journals of Gerontology: Series A, 74(4), 519-527.

GENİŞLETİLMİŞ ÖZET

Çalışmanın amacı: Sağlıklı orta yaşlı bireylerde fiziksel aktivite düzeyi, kuvvet ve kognitif fonksiyonları arasındaki ilişkinin incelenmesidir.

Araştırma problemi: Inaktivite önemli bir halk sağlığı sorunudur. Modern toplumlarda inaktif yaşam ve fazla kalori alınımı nedeniyle obezite, kalp hastalıkları, kas-iskelet sistemi hastalıkları ve psikolojik bozukluklar hızla artmaktadır. Kesin nedeni tam olarak bilinmese de son yıllarda demans, Alzheimer ve Parkinson hastalıklarında da hızlı bir artışın olduğu rapor edilmektedir (Ruegsegger and Booth, 2018). Fiziksel aktiviteye katılımın, kuvvet ve maksimal oksijen kullanım kapasitesinin arttırılmasının söz konusu nörodejeneratif hastalıklar için önleyici birer faktör olacağı tartışılmaktadır (Adamo et al., 2020; Zammit et al.,2019). Dolayısıyla son yıllarda, fiziksel aktivite düzeyinin ve fiziksel fitness parametrelerindeki gelişimin, nörodejeneratif hastalıkların yordayıcısı olup olamayacağı ile ilgili çalışmaların sayısı giderek artmaktadır (Yang et al.,2022, Frith and Loprinzi,2018; Alves et al.,2012).

Araştırma Soruları: Sağlıklı Fiziksel aktivite düzeyi ve kuvvet, kognitif fonksiyonların yordayıcısı olabilir mi?

Literatur Araştırması: Kuvvet ve yürüme hızı gibi fiziksel fonksiyonlar genel sağlığın göstergesi olarak kabul edilmektedir (Zammit et al.,2019).Clouston ve ark. (2013) gelişmiş fiziksel fonksiyonların, iyi durumdaki kognitif fonksiyonların göstergesi olduğunu bildirilmektedir. Ek olarak, demans ve hafif düzeyde kognitif fonksiyon bozukluğu olan bireylerde, yürüme hızında düşüş ve kavrama kuvvetindeki azalmanın kognitif fonksiyonlardaki bozulmanın erken göstergesi olabileceği iddia edilmektedir (Adamo et al.,2020).

Ruegsegger ve Booth'e (2018) göre, fiziksel aktivite; Alzheimer ve Parkinson' hastalıklarını içeren nörodejeneratif hastalıklarla, depresyon, anksiyete, ilaç bağımlılığı, kognitif fonksiyonlar ve mental sağlık için girişimsel olmayan bir terapi olarak kabul edilmektedir.

Cattuzzo ve ark (2016), kuvvetin fiziksel fitnes'ın sağlıkla ilgili en önemli komponentlerinden biri olduğunu belirtmektedirler.

Bir kuvvet egzersiz modalitesi olan, direnç egzersizlerinin yetişkin bireylerde, mental sağlığı geliştirdiği, yorgunluk, anksiyete ve depresyonu azalttığı, osteoartrit, fibromiyalji ve kas–iskelet sistemi gibi hastalıklarda ağrıyı azalttığı, kognitif fonksiyonların yanı sıra öz-güven gelişimine katkıda bulunduğu belirtilmektedir (Smolarek et al.,2016; Westcott, 2012; Kimura et al.,2010).

Kavrama kuvvetinin vücudun genel kuvvet düzeyi ile genel sağlığın bir göstergesi olduğu ve yaşlanmanın güçlü bir biyolojik göstergesi olduğu kabul edilmektedir(McGrath et al.,2018). Azalmış bir kavrama kuvveti ile şematik kategorizasyon, dikkat, konuşma becerileri ile kısa süreli hafızayı içeren kognitif fonksiyon skorlarında pozitif yönlü ilişkinin olduğu bildirilmektedir (Guerrero-Berroa, 2014; Buchman, et al., 2007).

Literatür incelendiğinde, Ohsugi ve ark., (2014), ile Alonso ve ark., (2016) çalışmalarının dışında genellikle kuvvet ve kognitif fonksiyon ilişkisini inceleyen çalışmalarda kuvvet düzeyinin belirlenmesi için kavram kuvveti testinin kullanıldığı anlaşılmaktadır. Ohsugi ve ark., (2014) çalışmalarında ise alt ekstremite kuvveti portatif dinamometre, Alonso ve ark., (2016) çalışmalarında ise alt eksremite kuvveti izokinetik dinamometre ile ölçülmüştür.

McGrath ve ark (2018) kavrama kuvvetinin vücudun genel kuvvet düzeyinin bir göstergesi olduğunu belirtirken, Adamo ve ark. (2020), ise kavrama kuvveti testinin 65 yaşından genç bireylerde kognitif fonksiyonların bir göstergesi olarak kullanılamayacağını belirtmektedir. Kuvvet düzeyi, kavrama kuvveti testi dışında bir testle değerlendirildiğinde ise, Frith ve Loprinzi (2018) ile Alonso ve ark. (2016), alt ekstremite kuvvet düzeyinin kognitif fonksiyonların güçlü bir yordayıcısı olduğunu belirtmektedir. Diğer taraftan, Ohsugi ve ark., (2014) alt ekstremite kuvvetinin, kognitif fonksiyonlardaki bozulmanın bir göstergesi olamayacağını savunmaktadır.

Yöntem / Methodology: Çalışmaya 12 si erkek toplam 43 katılımcı alındı (Yaş: 42.31± 9.76 yıl; Vücut ağırlığı: 71.42±14.85 kg; Boy uzunluğu: 162.33±7.96 cm) . Onsekiz yaşından büyük olmak, nörolojik bozukluğu, kas-iskelet sistemi yaralanması olmamak ve kardiyovasküler hastalığı olmamak çalışmaya dâhil edilme kriteri olarak belirlenirken, Kognitif bozukluk ya da herhangi bir ruhsal bozukluk nedeniyle tedavi görenler çalışmadan dışlandı. Katılımcıların fiziksel aktivite düzeyleri, Türkçe geçerlik güvenirliği Sağlam ve ark (2010) tarafından yapılan Uluslarasası Fiziksel Aktivite Anketinin kısa formu ile değerlendirildi. Katılımcılar ilk gün antropometrik ölçümlerin ardından, kavrama kuvveti 1 Maksimum Tekrar (MT) bench press, 1 MT Leg press, 1 MT leg extension, 1 MT Long pulley ve 1MT overhead press açısından değerlebdirildiler. 1 MT kuvvet testleri, Technogym Selection 900 marka makinada yapıldı. Kuvvet ölçümlerimden önce 10 dakikalık jogging ve 5 dakikalık germe egzersizi uygulandı. Katılımcılar, tahmini bir ağırlığı tükenene kadar kaldırmaya çalıştılar ve indirekt 1 MT, Brzycki, (1993), Formülü kullanılarak hesaplandı.

1 MT= (Kaldırılan Ağırlık / [1,0278-(Yapılabilen tekrar sayısı*0,0278)]

Kavrama kuvveti, el dinamometresinde gövde dik olarak dominant tarafından 1 dk. arayla 3 kez alındı ve en iyi değer istatistiksel analiz için kullanıldı. Ölçüm esnasında, dominant tarafın iç yüzü gövdeye dönüktü ve gövde ile kol arasında 30-45 açı korunmaya çalışıldı.

Ölçümlerin ikinci gününde kognitif fonksiyon testleri yapıldı. Katılımcıların inhibisyon özelliğinin belirlenmesinde Go/No-Go (Yap/Yapma) testi kullanılmıştır. Yap- Yapma görevinde X ve O görselleri uyarıcı olarak kullanılmıştır. Yap-Yapma görevinde hedef uyarıcı (yap) X görselidir. O görseli ise hedef olmayan (yapma) uyarıcıdır. Katılımcıların görevi hedef uyaranı gördüğünde mümkün olduğunca çabuk mouse'un sol butonuna basmak; hedef olmayan uyaranı gördüğünde tuşa basma tepkisini ketlemektir. Görevde toplam 200 uyarıcı bulunmaktadır. Uyarıcıların 100'ü (% 50) hedef uyarıcı (yap), 100'ü (% 50) ise hedef olmayan uyarıcıdır (yapma). Hedef ve hedef olmayan 27 uyarıcının ekranda kalma süresi (stimulus duration) 50 milisaniyedir. Bu uyarıcıların hemen ardından 1450 milisaniye uzunluğunda siyah ekran gelmektedir. Dolayısıyla bir uyarıcının başlangıcından diğer uyarıcının başlangıcına kadar olan süre (SOA) 1500 milisaniyedir. Bu durumda uyarıcılar arası zaman aralığı (ISI) 1450 milisaniyedir. Görev yaklaşık olarak 5 dakika 40 saniye sürmektedir. Katılımcıların dikkat düzeylerinin belirlenmesinde d2 dikkat testi kullanılmıştır. D2 testi seçici dikkat ve zihinsel konsantrasyon düzeyinin ölçüm yöntemlerinden birisidir. Bu testin ön sayfasında katılımcının kişisel bilgileri ve performans sonuçlarının kaydedileceği kısım ve bir deneme satırı bulunmaktadır. Testin sonraki sayfasında standart test formu yer almaktadır. Testin her bir sayfasında 47 işaretli harf bulunan 14 satır vardır. Her satırda bir, iki, üç ve dört küçük işareti olan "p" ve "d" harflerinden oluşan 16 farklı harf yer almaktadır. Testin uygulama esnasında katılımcı, ilgili olmayan diğer harfleri görmezden gelerek iki işareti olan "d" harflerini bulmak ve üzerini çizmek için satırları taraması gerekmektedir. Katılımcıya her bir satır için 20 saniye süre verilir. D2 Test puanları ve anlamları aşağıda verilmiştir (Brickenkamp ve Zillmer, 1998). İşlenen Toplam Madde Sayısı (TN): İlgili olan ilgili olmayan, tüm işlenen maddeler için performansın niceliksel olarak ölçülmesidir. Toplam Hata (E); İşaretlenmemiş (E1) ve yanlış işaretlenmiş harfleri (E2) kapsar. Hata Yüzdesi (%E); Performansın niteliksel yönünün ölçülmesinde kullanılan bir değişkendir. İşlem gören tüm maddeler içerisinde yapılan hata oranını gösterir. Hata oranının azalması; katılımcının doğruluğunu, işin niteliğini ve dikkatlilik derecesini artırır. Konsantrasyon Performansı (CP); Doğru olarak işaretlenmiş ilgili maddelerin sayısından, E2'nin çıkarılması sonucunda bulunmaktadır. Dalgalanma Oranı (FR); İşlem gören maksimum sayıdaki madde ile minimum sayıdaki madde sayısı arasındaki farktır. Toplam Madde-Hata (TN-E); Taranan toplam madde sayısından hata puanının çıkarılması ile belirlenir. TN-E, toplam performansı gösteren bir puandır, yüksek oranda güvenilirdir ve performansın doğruluğu ve hızı arasındaki ilişkinin ölçümünü gösterir. Elde edilen TN-E puanın yüzdelik dilimlerine bakıldığında % 50-60 kötü, % 60-70 vasat, % 70-85 normal, % 85 üzeri iyi olarak tanımlanmaktadır.

Sonuç ve Değerlendirme: Çalışma sonuçlarına dayanarak, kuvvet ve fiziksel aktivite düzeyinin sağlıklı orta yaşlı bireylerde kognitif fonksiyonların yordayıcısı olamayacağı söylenebilir. Kuvvet, fiziksel aktivite düzeyi ile kognitif fonksiyon ilişkisinin daha iyi anlaşılabilmesi için benzer çalışmaların daha buyuk örneklem grubu ile tekrarı farklı sonuçların alınmasına ve problemin çözümünün daha iyi anlaşılmasına yardımcı olabilir.