Malnutrition and Handgrip Strength are Correlated in Community Dwelling Elderly

Toplum İçinde Yaşayan Yaşlılarda Malnütrisyon ve El Kavrama Gücü İlişkilidir

Araştırma
Research

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Abstract
Abstract
Aim: Hand grip strength (HGS) is a useful tool to assess the nutritional status of the elderly. The aim of the study is to explore the relationship between nutritional status and hand grip strength in the elderly.
Method: 195 patients over the age of 65 were included. 60 were malnourished, 65 were at the risk of malnutrition and 70 were well–nourished. Patients Underwent Mini Nutritional Assessment–Short Form (MNA–SF), Katz Index of Independence in Activities of Daily Living (Katz Index ADL) and Lawton&Brody Instrumental Activities of Daily Living Scale (Lawton&Brody IADL). One way ANOVA was used to compare more than two independent samples with normal distribution. To be able to reveal a linear relationship between variables Pearson's correlation was used.
Results: Well–nourished elderly had higher scores in HGS (p=0.003), Katz Index ADL (p=0.004) and Lawton&Brody IADL (p=0.003). A moderate to high positive correlation was observed between HGS and MNA–SF (p=0.001, r:0.654), a weak to moderate correlation was between MNA–SF and Body Mass Index (BMI) (p=0.001, r:0.346).
Conclusion: Handgrip strength should be an essential part of the physical examination in the elderly.
Keywords: activities of daily living; aged; hand strength; malnutrition

Özet
Amaç: El kavrama gücü (EKG), yaşlıların beslenme durumunu değerlendirmek için yararlı bir araçtır. Çalışmanın amacı yaşlılarda beslenme durumu ile el kavrama gücü arasındaki ilişkiyi araştırmaktır.
Yöntem: 65 yaş üstü 195 hasta çalışmaya dahil edilmiştir. Hastaların 60'ı malnütrisyonlu, 65'i malnütrisyon riski altında ve 70'i iyi beslenmişti. Hastalara Mini Nutrisyonel Değerlendirme-Kısa Formu (MNA-SF), Katz Günlük Yaşam Aktivitelerinde Bağımsızlık Endeksi (Katz İndeksi GYA) ve Lawton&Brody Enstrümantal Günlük Yaşam Aktiviteleri Ölçeği (Lawton&Brody EGYA) uygulandı. Normal dağılıma sahip ikiden fazla bağımsız örneklemi karşılaştırmak için tek yönlü ANOVA kullanılmıştır. Değişkenler arasında doğrusal bir ilişkiyi ortaya koyabilmek için Pearson korelasyonu kullanılmıştır.
Bulgular: İyi beslenen yaşlıların EKG (p=0,003), Katz İndeksi GYA (p=0,004) ve Lawton&Brody EGYA (p=0,003) puanları daha yüksekti. El gücü ile MNA-SF arasında orta ile yüksek düzeyde bir pozitif korelasyon (p=0,001, r:0,654), MNA-SF ile Beden Kütle İndeksi (BKİ) arasında zayıf ile orta bir korelasyon (p=0,001, r:0,346) gözlenmiştir.
Sonuç: El kavrama gücü yaşlılarda fizik muayenenin önemli bir parçası olmalıdır.
Anahtar Sözcükler: günlük yaşam aktiviteleri; yaşlı; el kavrama gücü; malnütrisyon

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Introduction

Malnutrition and related outcomes are getting more common due to ongoing increase in geriatric population, both in Türkiye and worldwide (1). Malnutrition in elderly is closely associated with those pathologies which results in loss of autonomy, decreased quality of life, increased admissions to health services and duration of hospitalization, infectious disorders, wound heal delaying, gait disturbances, falls, fractures and premature deaths (2). According to the harmonization of four different prevalence studies, malnutrition prevalence is found to be 11% in community dwelling (CD) elderly, aging at least 65 years (3). Recently, another study from Türkiye declares that Global Leadership Initiative on Malnutrition criteria–based assessment of malnutrition prevalence is 24.5% in CD elderly (4).

In the elderly, Mini Nutritional Assessment (MNA) is especially recommended to assess malnutrition or being at risk of malnutrition (5). In short–form MNA (MNA–SF), Body Mass Index (BMI), loss of appetite, weight loss in last three months, autonomy and mobility of the patient, neuro–psychiatric disorders such as dementia or depression are all questioned. Mini Nutritional Assessment long and short forms are validated as being suitable for use in malnutrition screening of Turkish elderly (6). Malnutrition has negative effects on many functions of the body. Therefore, untreated malnutrition leads to increased morbidity and mortality rates in the elderly (7,8). Physical, psychological and socio-economic problems in the elderly lead to malnutrition, shortened life expectancy and decreased quality of life (9,10). Malnutrition can lead to decreased resistance, falls, hip fractures in geriatric individuals, prolonged healing times, increased infection, delayed wound closure and an increase in pressure sores (11). These changes result in prolonged hospitalization, repeated hospitalizations, increased medication use, difficulties in care, the need for transition to nursing homes, reduced quality of life and increased costs (12,13).

Katz Index ADL and Lawton&Brody IADL are very widely used tools in assessment of functional status of the elderly.

Aging decreases the muscle mass and strength, accelerates the loss of physical capabilities, and consequently results in increased morbidity and mortality (14). HGS measurement is a reliable method for evaluating overall well–being and quality of physical activity in elderly (15). It has been reported that low HGS is associated with falls, weakness, and deterioration in health–related quality of life, prolonged hospitalization, and increased mortality (16).

Muscle function is affected by malnutrition at an early stage, and HGS is gaining significant importance as a marker of nutritional status in nutritional intervention studies (17). Studies have shown that HGS is associated with patient's nutritional status revealed by screening tests, and the use of HGS can be used as an early diagnostic tool in the assessment of malnutrition risk (18).

In this day and time, anamnesis, physical examination, anthropometric measurements, examination of laboratory parameters, screening and evaluation tools are widely used to assess nutritional status of elderly. However, a simply usable screening tool would be very substantial in order to alarm both the clinician and the patient. The purpose of determining nutritional status of elderly is to get ahead of possible negative consequences originating from easily repairable deficiencies. The ideal screening method should be inexpensive, fast, valid, reliable, consistent and gradable, easy to apply, sensitive enough to detect all or nearly all patients with all aspects of malnutrition. There is even no need to mention that an insufficient nutritional status along with all clinical facets of elderliness gives rise to the loss of autonomy and mobility, increased frailty, increased risk of falls and fractures, increased hospital admission and hospitalization time, delayed wound healing and ultimately increased morbidity and mortality.

To date, studies examining the relationship between HGS and nutritional status in community-dwelling elderly are limited in number and, according to our literature review, only one study is available in Türkiye (19). This study aims at exploring the relationship between nutritional status and hand grip strength in the elderly.

Materials and Methods

This cross–sectional, observational and descriptive study was conducted with a sum of 195 patients who were over the age of 65. 60 patients, who

were diagnosed as malnourished, were included in group 1, 65 patients, who were at the risk of malnutrition risk, were annumerated in group 2, and 70 were in normal nutritional status, so assigned in group 3. All of them had been being followed up in geriatric outpatient clinic since at least one year. The study lasted from January to March 2022. The population of the study consisted of 900 elderly patients who applied to the geriatrics outpatient clinic in a 3-month period. Those of patients, who were unable to respond questionnaires, suffering from a mental or physical illness, living in a nursing home, having a malignant disease or a gastrointestinal disturbance causing malnutrition was excluded from the study. Each patient was informed, and accordingly an informed consent was obtained. No sample calculation was made and the elderly who were 65 years-old or above and agreed to participate in the study were included. The study was completed with 195 patients, which is approximately 22% of the population.

All patients received MNA–SF questionnaire through face–to–face interview in the outpatient clinic. The demographic characteristics such as age, sex, height, weight, marital status, residential status (living alone, with spouse, children or relatives), educational background, whether the patient does regular physical activity or not, co–morbidities (diabetes mellitus, hypertension, cardiovascular diseases, neuropsychiatric disturbances, musculoskeletal disorders, respiratory tract diseases etc.) and polypharmacy (currently using ≥4 drugs) were noted down during this interview. While inquiring the physical activity habits, they were asked how many days a week they had been engaging in a physical activity, such as going for a brisk walk, and how many minutes this physical activity had been lasting each time. The elderly who stated that they had regularly a brisk walking or similar physical activity for at least 150 minutes and at least 3 days a week since at least one year were considered physically active (20). Those who stated in the face–to–face interview that they are currently smoking were considered as smokers. And, those who stated that they had been drinking alcohol for at least one year and once or more a week were included in the alcohol user group.

Scales Used in the Study

Mini Nutritional Assessment

Nutritional statuses of elderly were handled by using a MNA-SF questionnaire. Mini Nutritional Assessment Short–Form is an shortened and validated form of MNA-SF, and already has been used in certain researches before, involves of a six–question subset of the complete MNA and BMI value as an anthropometric measurement. The maximum score that could be given on the MNA-SF questionnaire is 14. The participants were stratified according to the nutritional status, as being well–nourished (12–14 points), at risk of malnutrition (8–11 points) and malnutrition (0–7 points).

Katz Index of Independence in Activities of Daily Living

A total of six items, bathing, dressing, toileting, transferring, continence and feeding are evaluated. A highest score of 6 points means spotlessly independent and the lowest score of 0 indicates that the individual is entirely dependent.

Lawton&Brody Instrumental Activities of Daily Living Scale

Phone using, shopping, food preparation, independently movement, doing laundry, keeping track of own medications, housekeeping, and handling financial issues are evaluated. A maximum 8 points indicates the highest degree of independence.

Muscle strength

The tool assesses the HGS of the dominant hand. A Jamar hydraulic dynamometer was used. Handgrip strength was measured while the patient was sitting with 90° flexed elbow and a straight wrist. Patients in that position were asked to squeeze the tool between their four finger and palm of the dominant hand for 5 s as strongly as they could, three times with 30 s resting intervals and the best performance was recorded. In Turkish society, while the mean HGS with the dominant hand for men aged 60–69 is determined to be 34.6±6.9 kg and 27.5±9.1 kg for those aged ≥70; the mean HGS in the same age ranges of Turkish women is observed to be 21.9±4.5 kg and 17.4±5.1 kg, respectively (21).

Ethical Considerations

Ethics committee approval was obtained from Gaziantep Islam Science end Technology University Non-Invasive Clinical Research

Ethics Committee with the number (Decision No:2021/30). All procedures were performed in harmony with the Helsinki Declaration of 1975, as revised in 2013.

Data Analyses

Statistical analyses were accomplished by using SPSS 22.0 software. Kolmogorov–Smirnov test was used for normality testing. Descriptive statistics were presented by mean ± standard deviation (SD) for groups exhibiting a normal distribution of continuous variables. Descriptive statistics with regard to categorical variables were produced in the form of frequencies or percentages.

The correlation coefficient takes values between -1 and +1. r=0.00 no relationship, r=0.01-0.29 low level of association, r= 0.30-0.70 moderate relationship, r=0.71-0.99 high level relationship r=1.00 perfect relationship (22). Levene test was used for assessment of homogeneity of variances. One way ANOVA was used to compare more than two independent samples displaying normal distribution. Tukey HSD and Tamhane T2 tests were performed for further multiple comparisons, followed by ANOVA. Multiple comparisons of independents samples, if at least one of which do not display normal distribution, were executed by Kruskal Wallis median test. To be able to reveal a linear relationship between variables Pearson's correlation was used. Two sided values of $p<0.05$ was considered as statistically significant.

Results

There was no statistically significant difference among the groups in terms of age, gender, smoking and alcohol usage habits, marital and residential status, educational level, co–morbidities, and regular daily drug use. On the other hand, percentage of those who do regular physical activity differs significant among groups (p=0.011). Regular exercising was more common in group 3 in comparison to group 2 (p=0.018), and group 1 (p=0.001). Group 1 also differed significantly from Group 2 (p=0.022). Also, BMI of malnutrition group was markedly different from well–nourished group (p=0.039) (Table 1). Katz Index ADL (p=0.004), Lawton&Brody IADL (p=0.005), MNA–SF (p=0.001), and HGS (p=0.003) measurements display marked difference when the patients were stratified according to the nutritional status. Katz Index ADL scores was the highest in group 3 in comparison to group 1 (p=0.008), and group 2 (p=0.007). Group 1 and 2 also significantly differed from each other (p=0.038). The mean Lawton&Brody IADL scores was also the highest in Group 3 in comparison to group 1 (p<0.001), and Group 2 (p=0.025). Group 1 and 2 also significantly differed from each other (p=0.027). As for MNA–SF, Group 3 markedly differed from others (for Group 1 comparison, p=0.001; Group 2 comparison, p=0.004). Group 1 and 2 also significantly differed from each other (p=0.004). HGS score was significantly higher in Group 3 (Group 1–2, p=0.060; Group 1–3, p<0.001; Group 2–3, p=0.004) (Table 2).

When the correlation between HGS, BMI and MNA-SF was analyzed, it was observed that there was a moderate positive correlation between HGS and MNA-SF (p=0.001, r:0.654), a weak correlation between MNA-SF and BMI (p=0.001, r:0.346), and a weak correlation between HGS and BMI (p=0.007, r:0.197) (Table 3).

Discussion

The activity of daily living ratings were observed to increase with improved nutritional status. The results of our study are supported by numerous national and international publications on the older population, namely those aged 65 and above (19, 23, 24). Many studies have shown that elderly people without malnutrition are more independent in their activities of daily living, and patients whose malnutrition is improved also have improved activities of daily living (25-27). In a randomised controlled trial conducted by Yoshimura et al. examining the effects of nutritional supplements on muscle mass and activities of daily living in elderly rehabilitation patients with reduced muscle mass, they found that nutritional intervention added to resistance training during recovery rehabilitation can improve skeletal muscle mass and activities of daily living (28). These results suggest that there is a cause-and-effect relationship between nutritional recovery and functional recovery.

One of the expected and striking results of our study was that the highest percentage of the elderly who performed regular physical activity was observed in the well-nourished group. This result is similar to the literature and shows two-way results. It is seen that both the elderly who do physical exercise are better nourished and the

Table 1. Demographic characteristics, BMI, regular physical activity habits, smoking/alcohol usage, number of daily drugs being used, co-morbidities, residential, educational and marital status.

	Malnutrition Group 1 (n=60)	At risk of malnutrition Group 2 (n=65)	Well–nourished Group 3 (n=70)	p
Age	73.8±7.1	72.2±6.2	71.5±5.2	0.471
Gender (%):				
Male	38.3	43.1	34.3	0.577
Female	61.7	56.9	65.7	
BMI	26.9±6.3€	29.1±5.1	30.0±5.3*	**0.039**
Smoking (%)	30.8	33.3	35.9	0.383
Alcohol (%)	5.0	7.7	1.4	0.152
Regular Physical Activity (%)	13.3#,€	15.7*,€	21.5*,#	**0.011**
Living Alone (%)	32.1	28.6	39.3	0.496
Married	70.0	75.4	68.6	0.496
Education Status (%):				
Uneducated	51.7	44.6	64.3	0.140
Elementary	36.7	41.5	27.1	
High school graduate	5.0	7.7	7.1	
University graduate	6.6	6.2	1.5	
Co–morbidities (%):				
Diabetes mellitus	35.0	26.2	34.3	0.746
Cardiovascular disease	31.7	33.8	37.1	
Cerebrovascular disease	15.0	13.8	10.0	
Respiratory disease	11.6	16.9	8.6	
Musculoskeletal disease	6.7	9.3	10.0	
Number of daily drugs being used	5.2±2.8	4.9±3.6	4.2±2.6	0.089

BMI, body mass index, ANOVA, Kruskal Wallis, $p<0.05$.
*, malnutrition group.
#, at risk of malnutrition group.
€, well–nourished group.

well-nourished elderly can exercise more (29-32). In a randomised controlled study conducted by Fiorilli et al., in which they examined the effect of long-term physical activity on the perception of quality of life, healthy nutrition and activities of daily living in the elderly, they concluded that patients had better nutrition and became independent in activities of daily living after regular physical activity (33). These results suggest that poor nutrition, sedentary lifestyle

Table 2. Acitivities of daily living and short form of mini-nutritional assessment scale scores.				
	Malnutrition Group 1 (n=60)	**At risk of malnutrition Group 2 (n=65)**	**Well–nourished Group 3 (n=70)**	**p**
Katz Index ADL[1]	4.4 ± 1.0$^{\#,€}$	4.9 ± 0.9$^{*,€}$	5.4 ± 0.92$^{*,\#}$	**0.004**
Lawton&Brody IADL[1]	5.1 ± 3.0$^{\#,€}$	6.5 ± 2.0$^{*,€}$	6.5 ± 2.53$^{*,\#}$	**0.005**
MNA-SF[1]	6.5 ± 1.6$^{\#,€}$	9.9 ± 1.7$^{*,€}$	12.7 ± 1.80$^{*,\#}$	**0.001**
HGS[2]	22.4 ± 14.1$^{€}$	25.2 ± 11.6$^{€}$	32.0 ± 15.1$^{*,\#}$	**0.003**

Katz Index ADL, Katz Index of Independent Activities of Daily Living; Lawton&Brody IADL, Lawton&Brody Instrumental Activities of Daily Living; MNA–SF, Mini nutritional assessment–short form; HGS, handgrip strength, ANOVA, Kruskal Wallis, $p<0.05$.
*, malnutrition group.
#, at risk of malnutrition group.
€, well–nourished group.

Table 3. Pearson's correlation analysis.						
	MNA–SF		**HGS**		**BMI**	
	r	**p**	**r**	**p**	**r**	**p**
MNA–SF	1.0		0.654	0.001	0.345	0.001
HGS	0.654	0.001	1.0		0.197	0.007
BMI	0.346	0.001	0.197	0.007	1.0	

BMI, body mass index; MNA–SF, Mini nutritional assessment–short form; HGS, handgrip strength.

and reduced muscle utilisation increase the loss of muscle mass and thus limit physical activity.

In our study, it was also found that the well–nourished elderly group, who had already involved more participants doing physical activity regularly, also had displayed significantly better HGS than the elderly with malnutrition or at risk of malnutrition. The HGS is accepted as the simplest measurement method that reveals the adequacy of well–being, physiological functionality, muscle strength and function, and even as a predictor of mortality and morbidity (15,34,35).

Previous studies show similar results with our study results. Although hand strength is a multifactorial condition, malnutrition is one of the important building blocks and causes of poor hand grip strength (36-38). It is expected that muscle mass and strength, which decrease with aging due to hormonal, genetic and phenotypic factors, will be delayed and reflected on hand strength with good nutrition and exercise.

The better the nutritional status of the elderly, the higher MNA–SF and HGS scores were encountered in our study. Lawton&Brody IADL and Katz Index ADL was also improving as the nutritional status was getting better. Despite the fact that there was not such a clear relation between BMI increment and nutritional status, BMI was markedly higher in the well–nourished group. Lastly, MNA–SF and BMI, and HGS and BMI were also correlating positively. As a result of nutritional support, it is observed that MNA scores increase significantly at the end of three months in malnourished elderly living in nursing homes, and HGS improves significantly at the end of these three months, independent of baseline BMI categories, as an indicator of muscle function and independency (21,39). Chilima et al. also reports that HGS positively correlates with BMI, upper arm circumference, and arm muscle area (40). Flood and colleagues not only detect HGS and malnutrition association, but also observe, in nearly 2–week follow–up, that HGS negatively correlates Patient–Generated Subjective Global Assessment questionnaire scores and predicts independently alterations in nutritional status (18). According to another one conducted with 604 hospitalized patients, being at risk of malnutrition or malnourished significantly increases the likelihood of getting lower scores

of HGS (41). These results are thought to be due to the fact that good nutrition is associated with long-term functional well-being and contributes significantly to muscle strength.

Limitation

Our study was conducted in elderly people who applied to the geriatrics outpatient clinic of a hospital in Gaziantep. Since the elderly who applied to other hospitals were not included in the study, the results of the study may represent only those who applied to this hospital.

In our study, the elderly who applied to the hospital as outpatients were included, and the elderly who received home care services, were bedridden, and lived in nursing homes were excluded from the study. The study does not represent all elderly aged 65 years and over.

Since our study was a cross-sectional analytical study, the margin of error may have increased due to the cross-sectional nature of our evaluations, since the elderly were not followed up and re-surveyed.

Conclusion

This cross–sectional study, which we conducted with a heterogeneous group of elderly patients who are with malnutrition, at the risk of malnutrition, and in well–nourished status, is momentous because it is the first study to investigate the effectiveness of HGS measurement to assess nutritional status of community dwelling elderly in Türkiye. The better the nutritional status of the elderly, the better their activities of daily living. Regular exercise is more frequent in groups with better nutritional status. Hand grip strength is best in the well-nourished group. Hand strength is associated with both malnutrition and body mass index. HGS should be an essential part of the physical examination, especially in the elderly. This simple and easily applicable test provides unique information about the patient. In future studies, the determination of cut–off values for this measurement according to age and gender and even co–morbidities will increase the effectiveness of the measurement.

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References

1. Clark AB, Reijnierse EM, Lim WK, Maier AB. Prevalence of malnutrition comparing the GLIM criteria, ESPEN definition and MST malnutrition risk in geriatric rehabilitation patients: RESORT. Clin Nutr. 2020;39(11):3504-11.
2. Jayanama K, Theou O, Blodgett JM, Cahill L, Rockwood K. Frailty, nutrition-related parameters, and mortality across the adult age spectrum. BMC Med. 2018;16(1):188.
3. Kiesswetter E, Colombo MG, Meisinger C, Peters A, Thorand B, Holle R, et al. Malnutrition and related risk factors in older adults from different health-care settings: an enable study. Public Health Nutr. 2020;23(3):446-56.
4. Demirdag F, Kolbasi EN, Pehlivan O. Prevalence of Malnutrition According to the Global Leadership Initiative on Malnutrition Criteria in Community-dwelling Older Adults in Turkey. Medeni Med J. 2022;37(3):234-9.
5. Doroudi T, Alizadeh-Khoei M, Kazemi H, Hormozi S, Taati F, Ebrahimi M, et al. Comparison of Two Validation Nutrition Tools in Hospitalized Elderly: Full Mini Nutritional Assessment and Short-form Mini Nutritional Assessment. Int J Prev Med. 2019;10:168.
6. Sarikaya D, Halil M, Kuyumcu ME, Kilic MK, Yesil Y, Kara O, et al. Mini nutritional assessment test long and short form are valid screening tools in Turkish older adults. Arch Gerontol Geriatr. 2015;61(1):56-60.
7. Dişli E, Samancıoglu S. Geriatrik Hastalarda Malnütrisyon Ve Düşme Riski Arasındaki İlişki. Karya Journal of Health Science. 2018;3(1):24-9.
8. Norman K, Haß U, Pirlich M. Malnutrition in Older Adults-Recent Advances and Remaining Challenges. Nutrients. 2021;13(8).
9. Hoogendijk EO, Flores Ruano T, Martínez-Reig M, López-Utiel M, Lozoya-Moreno S, Dent E, et al. Socioeconomic Position and Malnutrition among Older Adults: Results from the FRADEA Study. J Nutr Health Aging. 2018;22(9):1086-91.
10. Bardon LA, Corish CA, Lane M, Bizzaro MG, Loayza Villarroel K, Clarke M, et al. Ageing rate of older adults affects the factors associated with, and the determinants of malnutrition in the community: a systematic review and narrative synthesis. BMC

geriatrics. 2021;21:1-39.
11. Kupisz-Urbanska M, Marcinowska-Suchowierska E. Malnutrition in Older Adults-Effect on Falls and Fractures: A Narrative Review. Nutrients. 2022;14(15).
12. Valk-Draad MP, Bohnet-Joschko S. Nursing Home-Sensitive Hospitalizations and the Relevance of Telemedicine: A Scoping Review. International journal of environmental research and public health. 2022;19(19).
13. Chiavarini M, Ricciotti GM, Genga A, Faggi MI, Rinaldi A, Toscano OD, et al. Malnutrition-related Health outcomes in older adults with hip fractures: a systematic review and Meta-analysis. Nutrients. 2024;16(7):1069.
14. Larsson L, Degens H, Li M, Salviati L, Lee YI, Thompson W, et al. Sarcopenia: Aging-Related Loss of Muscle Mass and Function. Physiol Rev. 2019;99(1):427-511.
15. Bohannon RW. Grip Strength: An Indispensable Biomarker For Older Adults. Clin Interv Aging. 2019;14:1681-91.
16. Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age Ageing. 2011;40(4):423-9.
17. Norman K, Stobaus N, Gonzalez MC, Schulzke JD, Pirlich M. Hand grip strength: outcome predictor and marker of nutritional status. Clin Nutr. 2011;30(2):135-42.
18. Flood A, Chung A, Parker H, Kearns V, O'Sullivan TA. The use of hand grip strength as a predictor of nutrition status in hospital patients. Clin Nutr. 2014;33(1):106-14.
19. Kılıç C, Önal A, Tufan G, Karan M, Bahat-Öztürk G. Geriatri Polikliniğinden Takip Edilen 75 Yaş Üstü Bireylerin Nütrisyonel Değerlendirmesi ve Fonksiyonel Kapasiteleri ile İlişkisinin Araştırılması. Akademik Geriatri Dergisi. 2014;6.
20. Boulton ER, Horne M, Todd C. Multiple influences on participating in physical activity in older age: Developing a social ecological approach. Health Expect. 2018;21(1):239-48.
21. Unal M, Kose O, Arik HO, Guler F, Acar B, Yuksel HY. Hand grip strength: Age and gender stratified normative data in Anatolian population. Hand and Microsurgery. 2018;7(1):16-.
22. Akbulut Ö. Korelasyon ve regresyon. Baykul Y, editor: Pegem Akademi; 2016. 257-93 p.
23. Nagai K, Komine T, Ikuta M, Gansa M, Matsuzawa R, Tamaki K, et al. Decline of instrumental activities of daily living is a risk factor for nutritional deterioration in older adults: a prospective cohort study. BMC Geriatr. 2023;23(1):480.
24. Wei K, Nyunt MSZ, Gao Q, Wee SL, Ng TP. Long-term changes in nutritional status are associated with functional and mortality outcomes among community-living older adults. Nutrition. 2019;66:180-6.
25. Ekici E, Çolak MY, Kozan EH. Huzurevinde yaşayan yaşlıların beslenme durumları ve günlük yaşam aktivitelerinin belirlenmesi. Online Türk Sağlık Bilimleri Dergisi. 2019;4(4):506-18.
26. Kiriş Y. Kayseride yaşayan altmış beş yaş ve üzeri bireylerde beslenme ile günlük yaşam aktiviteleri arasındaki ilişkinin değerlendirilmesi. Kayseri: Erciyes Üniversitesi 2015.
27. Nishioka S, Wakabayashi H, Nishioka E, Yoshida T, Mori N, Watanabe R. Nutritional improvement correlates with recovery of activities of daily living among malnourished elderly stroke patients in the convalescent stage: a cross-sectional study. Journal of the Academy of Nutrition and Dietetics. 2016;116(5):837-43.
28. Yoshimura Y, Uchida K, Jeong S, Yamaga M. Effects of nutritional supplements on muscle mass and activities of daily living in elderly rehabilitation patients with decreased muscle mass: a randomized controlled trial. The Journal of nutrition, health and aging. 2016;20(2):185-91.
29. Artaza-Artabe I, Sáez-López P, Sánchez-Hernández N, Fernández-Gutierrez N, Malafarina V. The relationship between nutrition and frailty: Effects of protein intake, nutritional supplementation, vitamin D and exercise on muscle metabolism in the elderly. A systematic review. Maturitas. 2016;93:89-99.
30. da Rosa Camargo L, Doneda D, Oliveira VR. Whey protein ingestion in elderly diet and the association with physical, performance and clinical outcomes. Experimental Gerontology. 2020;137:110936.
31. Karagoz S, Kocaer HO, Unveren A. Düzenli egzersiz yapan 60 yaş ve üzeri bireylerin

sağlıklı beslenmeye ilişkin tutumları ve bilişsel esneklik durumlarının yaşam doyumu üzerine etkisi. Journal of ROL Sport Sciences. 2023;4(1):208-28.
32. Ge L, Yap CW, Heng BH. Association of nutritional status with physical function and disability in community-dwelling older adults: a longitudinal data analysis. Journal of nutrition in gerontology and geriatrics. 2020;39(2):131-42.
33. Fiorilli G, Buonsenso A, Centorbi M, Calcagno G, Iuliano E, Angiolillo A, et al. Long term physical activity improves quality of life perception, healthy nutrition, and daily life management in elderly: A randomized controlled trial. Nutrients. 2022;14(12):2527.
34. Bohannon RW. Muscle strength: clinical and prognostic value of hand-grip dynamometry. Curr Opin Clin Nutr Metab Care. 2015;18(5):465-70.
35. Rantanen T. Muscle strength, disability and mortality. Scand J Med Sci Sports. 2003;13(1):3-8.
36. Ahn SH, Park EB, Seo S, Cho Y, Seo DH, Kim SH, et al. Familial Correlation and Heritability of Hand Grip Strength in Korean Adults (Korea National Health and Nutrition Examination Survey 2014 to 2019). Endocrinology and Metabolism. 2023;38(6):709-19.
37. Hong S. Association of relative handgrip strength and metabolic syndrome in Korean older adults: Korea National Health and Nutrition Examination Survey VII-1. Journal of obesity & metabolic syndrome. 2019;28(1):53.
38. Zhang XS, Liu YH, Zhang Y, Qing X, Yu XM, Yang XY, et al. Handgrip strength as a predictor of nutritional status in Chinese elderly inpatients at hospital admission. Biomedical and Environmental Sciences. 2017;30(11):802-10.
39. Malafarina V, Serra Rexach JA, Masanes F, Cervera-Diaz MC, Lample Lacasa L, Ollero Ortigas A, et al. Results of High-Protein, High-Calorie Oral Nutritional Supplementation in Malnourished Older People in Nursing Homes: An Observational, Multicenter, Prospective, Pragmatic Study (PROT-e-GER). J Am Med Dir Assoc. 2021;22(9):1919-26 e5.
40. Chilima DM, Ismail SJ. Nutrition and handgrip strength of older adults in rural Malawi. Public Health Nutr. 2001;4(1):11-7.
41. Amasene M, Besga A, Medrano M, Urquiza M, Rodriguez-Larrad A, Tobalina I, et al. Nutritional status and physical performance using handgrip and SPPB tests in hospitalized older adults. Clin Nutr. 2021;40(11):5547-55.