OPEN ACCESS

ISSN: 2091-2889 (online)
2091-2412 (print)

Received: 07 Jul 2025
Accepted: 12 Aug 2025
Published: 31 Aug 2025

DOI: 10.54ZA530/jcmc.1744

Handgrip strength and endurance of apparently healthy subjects

Sanyukta Gurung[1], Narayan Bahadur Mahotra[2], Lava Shrestha[3], Yagya Laxmi Shakya[4], Neeti Bhat[5]

[1]Assistant Professor, Department of Integrated Basic Sciences, Physiology, Patan Academy of Health Sciences, Nepal
[2,3]Associate Professor, Department of Clinical Physiology, Maharajgunj Medical Campus, Nepal
[4]Associate Professor, Department of General Practice and Emergency, Maharajgunj Medical Campus, Nepal
[5]Member, Research Institute for Collaborative Development, Kathmandu, Nepal

Peer reviewed

Abstract

Introduction: Musculoskeletal fitness, strength and endurance can be measured by hand grip strength (HGS) and endurance (HGE). This study aimed to assess HGS and HGE according to sociodemographic and personal habits.

Method: A cross-sectional descriptive study was conducted at Tribhuvan University Teaching Hospital from 2020 to 2022 among apparently healthy adults recruited by convenience sampling after ethical clearance. Bodybuilders, pregnant women, and those with a history of chronic illness were excluded. The HGS and HGE were measured by the Camry digital hand dynamometer. Age, gender, handedness, BMI, waist circumference, smoking, alcohol consumption and knuckle cracking habits were recorded. Data were checked for normality. Data were expressed descriptively using mean, frequency and percentage. Data were analysed with IBM SPSS v16.0.

Result: A total of 440 participants (332 males, 108 females), mean age 32.4±8.0 years, were included. The HGS was higher in males with 40.76+6.44 kg than in females, 26.49+4.00 kg, whereas females showed longer HGE 139.5±61.8 than males 125.3±46.9 s. The HGS peaked in men aged 25–29 years and women aged 35–39 years, whereas HGE was longest in 45–49 years, with women maintaining endurance longer than men at each age category. Higher BMI was associated with greater HGS but shorter HGE. Non-smokers and non-alcohol consumers had longer endurance than their counterparts.

Conclusion: Males had higher handgrip strength, and females had longer handgrip endurance. Higher BMI was associated with increased strength but reduced endurance. Non-alcohol consumers showed better endurance capacity.

How to cite

Gurung S, Mahotra NB, Shrestha L, Shakya YL, Bhat N. Handgrip Strength and Endurance of Apparently Healthy Subjects.Journal of Chitwan Medical College. 2025;15(54):82-8.

Correspondence

Sanyukta Gurung, Department of Integrated Basic Sciences, Physiology, Patan Academy of Health Sciences, Nepal. Email: sanyuktagurung@pahs.edu.np, Telephone: +977 9818854553

Introduction

Musculoskeletal disorder is classified in five major headings according to global burden of disease: gout, osteoarthritis, rheumatoid arthritis, low back pain and neck pain.[1] The highest prevalence of was reported in South Asia (114 million) in 2017 and age standardized point prevalence per 100,000 people was estimated highest in Bangladesh (7439) followed by India (7194) and Nepal (6798.9).[1] Disability adjusted life years (DALY) associated with musculoskeletal disorders increased by 61.6% from 1990 to 2016.[2]

The indicators for muscle fitness are muscle strength and endurance.[3] Muscle strength is the maximum load a muscle can lift or the maximum voluntary force applied by a skeletal muscle for a short duration of time.[4,5] Hand grip strength (HGS) is a simple method to assess muscle strength.[6] Forceful flexion of the joints of the fingers with maximal voluntary force by a subject produces a maximum hand grip strength which reflects the strength of the hand muscles and is measured in kilograms.[7] Ability to maintain a continuous hand grip until the onset of fatigue is called static hand grip endurance (HGE) whereas, to execute numerous grips for a time span until the onset of fatigue is called dynamic HGE.[8] The HGS is affected by age, gender, body posture, dominance of the hand, range of motion, body mass index (BMI), waist circumference (WC), alcohol, smoking, knuckle cracking habit, pain, occupation, ethnicity and fatigue.[7,9–14]

This study aims to assess the HGS and HGE of apparently healthy adults according to demographics and anthropometric measures.

Method

A cross-sectional descriptive study was conducted among apparently healthy adults accompanying patients in General Practice Out Patient Department and General Health Checkup Clinic of Tribhuvan University Teaching Hospital between June 2020 and May 2022. Participants were recruited using convenience sampling after obtaining ethical approval from the Institutional Review Committee (Reference number: 63(6-11) E2077/078).

Handgrip strength and endurance was measured using Camry hand dynamometer. The participants were instructed to apply maximum pressure on the dynamometer for 5 seconds. The procedure was repeated 3 times with an interval of 30 seconds.[15] The highest value was recorded as the HGS. The participants were asked to hold the dynamometer with maintained force of 30 percent of maximum voluntary contraction to measure HGE.[16] Edinburgh handedness inventory was used to assess handedness.[17] Self-administered physical activity readiness questionnaire was used to assess the physical activity readiness.[18]

Individuals aged 20–49 years were included. Bodybuilders, pregnant women, and those under medication or with a history of chronic medical conditions were excluded. Sample size was estimated based on population mean, with SD of 9.3 for men and 5.3 for women taken from earlier study.[19]

Data were entered into Excel and analysed using IBM SPSS 16. Categorical variables were presented as frequency and percentage, while continuous variables were expressed as mean±SD with 95% confidence intervals (CI).

Result

In this study was a total of 440 healthy adults (332 men, 108 women), mean age of 32.36±8.03 years (range: 20-49 years). Men demonstrated greater HGS than women (40.76±6.44 kg vs 26.49±4.00 kg), while women demonstrated longer HGE than men (139.51±61.79 s vs 125.29±46.94 s), Table 1.

For HGS performance left-handed men demonstrated highest strength (42.65±5.96 kg) than right-handed (40.71±6.49 kg) and ambidextrous (40.08±3.53 kg). For HGE left-handed males demonstrated longest endurance (150.90±55.10 s), while ambidextrous female had highest endurance, Table 2.

The relationship between age and grip performance revealed important trends, men reached their peak strength in the 25-29 year (42.38±6.41 kg), while women's peak strength occurred later, in the 35-39 year (27.21±3.32 kg).

However, the oldest age group (45-49 years) showed the greatest endurance for both genders (164.61±67.10 s), with women in this group maintaining their grip for 214.10±58.93 seconds, Figure 1.

Higher BMI was associated with greater strength but reduced endurance. The strongest grips were found in men with Class I obesity (42.74±5.81 kg) and women with Class II obesity (34.70±3.11 kg), while participants with Class II obesity showed the shortest endurance times (86.80±34.64 s), Table 3.

Waist circumference showed no clear relationship with either grip strength or endurance in this study, Table 4.

The participants who never consumed alcohol demonstrated longer endurance times than those who did (132.90±52.33 s vs 125.42±50.77 s). Smoking and knuckle-cracking habits showed no consistent effects on either strength or endurance, Table 5.

Table 1. Handgrip strength and endurance among apparently healthy adults, n=440

Handgrip	Male, 332		Female, 108		Total, 440	
	Mean±SD	95% CI	Mean±SD	95% CI	Mean±SD	95% CI
HGS (kg)	40.76±6.44	40.07-41.46	26.49±4.00	25.64-27.17	37.24±8.57	36.43-38.04
HGE (s)	125.29±46.94	120.22-130.36	139.51±61.79	127.72-151.30	128.78±51.28	123.98-133.59

Table 2. Mean handgrip strength and endurance in accordance to handedness among participants, n=440

Handgrip	Right hand		Left hand		Ambidextrous*	
	Mean±SD	95%CI	Mean±SD	95%CI	Mean±SD	95%CI
HGS (kg)						
Male	40.71±6.49	39.99-41.43	42.65±5.96	38.39-46.91	40.08±3.53	35.70-44.46
Female	26.31±3.77	25.56-27.07	26.90±6.79	19.77-34.03	27.88±5.82	18.62-37.13
HGE (s)						
Males	124.79±46.56	119.65-129.94	150.90±55.10	111.48-190.32	105.60±46.07	48.40-162.86
Females	138.07±60.65	125.91-150.23	147.50±89.73	19.77-34.03	162.75±53.97	76.87-248.63

Ambidextrous* measurement represents pre-dominant hand (

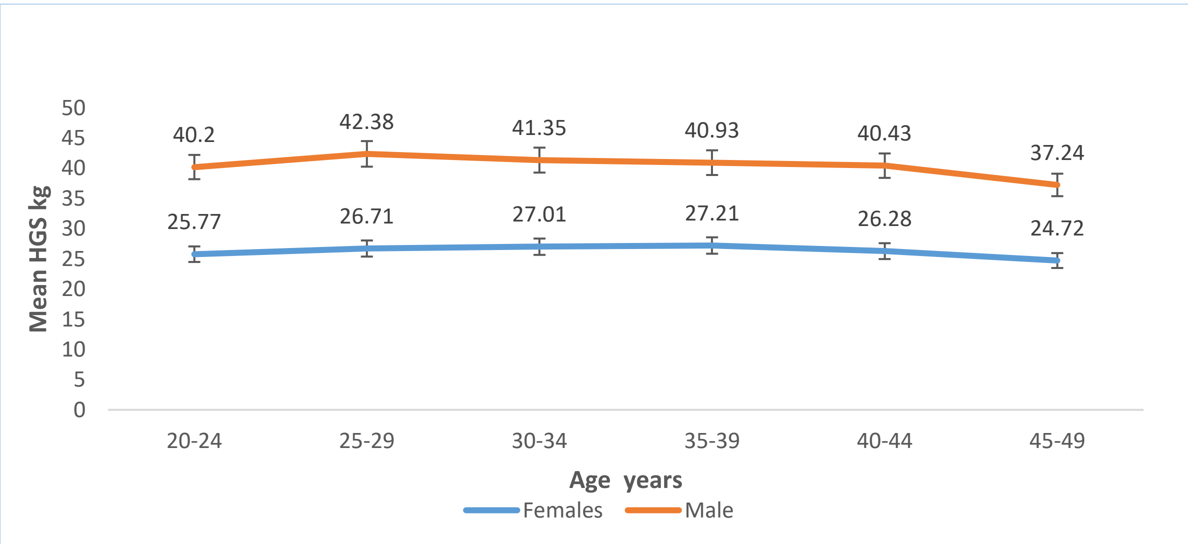

Figure 1 Mean dominant handgrip strength in age categories for male and female participants, n=440

Table 3. Body mass index (BMI) and HGS, HGE among male and female, n=440

BMI categories kg/m²	Male, 332 n(%)	HGS, Mean±SD(kg))	HGE Mean±SD (s)	Female, 108 n(%)	HGS, Mean±SD (kg))	HGE Mean±SD (s)
Underweight <18.5	11 (3.3%)	36.87±6.05	123.36±37	6 (5.6%)	24.05±3.05	168±54.02
Normal 18.5-24.9	168 (50.6%)	40.24±6.37	130.73±6.37	49 (45.4%)	25.27±4.04	130.18±64.04
pre-obese 25-29.9	132 (39.8%)	41.48±6.57	122±45.33	36 (33.3%)	26.49±3.90	143.97±56.97
class I obesity 30-34.9	18 (5.4%)	42.74±5.81	108.17±5.81	14 (13%)	26.75±3.35	154.29±71.68
class II obesity 35-39.9	3 (0.9%)	40.80±1.59	75.33±36.46	2 (1.9%)	34.70±3.11	104±33.94
class III obesity >40	-	-		1 (0.9%)	22.50	129

*BMI categories - The National Heart, Lung, and Blood Institute (NHLBI), https://www.nhlbi.nih.gov/ Link

Table 4. Waist circumference (WC) and HGS, HGE in male and female, n=440

WC (Male, 332)	n(%)	HGS, Mean ±SD (kg)	95 CI	HGE, Mean ±SD (s)	95 CI	WC (Female, 108)	n(%)	HGS, Mean ±SD (kg)	95 CI	HGE, Mean± SD (s)	95 CI
Normal ≤102cm	305 (91.9)	40.81± 6.32	40.10-41.53	126.93± 46.73	121.67-132.20	Normal <88 cm	69 (63.9)	26.08± 4.10	25.09-27.06	136.45± 60.10	122.01-150.89
Increased >102 cm	27 (8.1)	40.14± 7.81	37.06-43.23	106.78± 46.20	88.50-125.05	Increase>88cm	39 (36.1)	26.98± 3.82	25.74-28.22	144.92± 65.11	123.82-166.03

WC criteria- The National Heart, Lung, and Blood Institute (NHLBI), https://www.nhlbi.nih.gov/ Link

Table 5. Smoking, alcohol consumption and knuckle cracking habits and HGS, HGE in male and female, n=440

Habits	Male, 332 n(%)	HGS Mean±SD	HGE Mean±SD	Female, 108 n(%)	HGS Mean±SD	Mean HGE±SD
Smoking						
Non-smokers	213(64.2)	40.27±6.53	129.08±48.39	104 (96.3)	26.47±4.06	138.62±60.17
Past smokers	27 (8.1)	41.62±6.58	123.33±44.70	1 (0.9)	25.5	184
Current smoker	92 (27.2)	41.64±6.14	117.09±43.43	3 (2.8)	24.27±1.62	155.67±128.07
Alcohol						
Never	136 (41)	39.95±6.19	129.29± 48.09	65 (60.2)	26.35±4.25	140.45±59.95
Occasionally	188 (56.6)	41.35±6.51	122.53±46.59	43 (39.8)	26.48±3.66	138.09±65.17
Regularly	8 (2.4)	40.58±8.2	122.38±32.42	0	-	-
Knuckle cracking						
never	121 (36.4)	40.14±6.62	121.26±43.25	56 (51.9)	26.52±3.83	140.36±65.88
crack	211 (63.6)	41.12±6.32	127.60±48.88	52 (48.1)	26.28±4.22	138.60±57.69

Discussion

This study showed that HGS was more in males, HGE more in females. Majority of participants were right-handed (94%). The mean HGS peaked in age group 25-29 years for males and 35-39 years for females. The mean HGE was longer among the age group 45-49 years for both males and females.

Another study conducted in South Korea reported with a large sample size (n=23,716) and age inclusion range (above 10 years) reported that HGS in men (39.5±9.3kg) was higher than women (24.4±5.3kg).[19] A study conducted in Nepal among 526 participants from 19 to 70 years also showed men (43.48kg) had higher HGS than females (28.62kg).[20] The higher mean HGS in men may be explained by the larger size of fibers. The differences in distribution of lean mass also may contribute to the differences in HGS strength.[21] Testosterone enhances hypertrophy of skeletal muscle. A hypothesis suggests that testosterone by androgen receptor mediated pathway enhance differentiation of mesenchymal stem cells towards muscle cell pathway and inhibit the adipocyte pathway. Testosterone increases muscle fibre volume, enhance protein synthesis and reduce protein degradation, increase number of satellite cells and myonuclear cells.[22] These factors possibly cause increased mean HGS in males.

The peak of mean HGS occurs earlier among the male population (25-29 years) in comparison to their female counterparts (40-44 years) as observed in the study from United States of America.[23] In contrast to this, study from South Korea observed that the males and females reached the peak at the same age category (35-39 years), however, the incline and decline of peak HGS was steeper in the male population where HGS prominently increased (46±7.2 kg) up till the age of 35-39 years then declined rapidly whereas, the females showed a more gradual incline (27.2±4.6 kg) of HGS gradually up till the age group 35-39 years and then remained in an approximate plateau phase (26.5±4.7 kg) till 45-49 years then decreased (22.8±4.6 kg) after the age of 65-69 years.[19] In contrast to our study another study from Nepal observed that the peak of mean HGS was the same for both males and females (19-29 years).[20]

Skeletal muscle mass loss caused by aging have been reported to be different among males and females.[24,25] A hypothesis suggests that alterations in the sex steroid hormones due to age may increase (IL-6) interleukin 6 and C-reactive protein (CRP) level which suggest that alterations in sex steroid hormones caused by age may also have a role in loss of skeletal muscle mass.[26] Aging has been associated with muscle mass loss.[23] The narrow age range used to include apparently healthy adults in this study may have contributed to variations in the results.

In line to present study, an Indian study also observed that the mean of HGE to be more in females (45.05+20.81 s) than in males (38.66±20.5).[27] In contrast another Indian study observed males (80+20.07 s) had longer mean HGE than females (45.01±20.07s).[28] The longer endurance time in females may be explained by the differences of distribution of muscle fibre types. Females have more type I muscle fibers.[29]

In similarity to present study, study from USA observed that the male participants of the age group 40-49 years had higher mean HGE (143 s).[30] In contrast, study from India reported that a higher mean endurance for the male participants in the age group 30-30 years (164.1±42.2 s) for the right hand and (154.5±46.4 s) for the left hand.[31] It has been suggested that type II fibres are negatively associated to endurance. Morphological changes caused by aging may lead to decrease in lactate accumulation subsequently maintaining muscle endurance with age.[30]

Some of the limitation of our study include, being a descriptive cross-sectional study which does not determine the cause and outcome. Apparently healthy participants were recruited by convenience sampling technique; hence, the mean range may not be a representation of the general population due to selection bias. Adjustment of confounding factors could not be done due to limited resources which may have altered the results. The imbalance in male and female participants, small sample size in subcategories and descriptive nature of the study limits the findings. Bodybuilders, occupation and the type of exercise predominantly performed were not included which limits the study in understanding the improvement of musculoskeletal fitness.

Conclusion

This study concludes that males had high handgrip strength compared to females but handgrip endurance was longer in females compared to males. Peak in handgrip strength was associated with earlier age among males compared to females.

Author contribution

Concept design: SG, NBM, LS, NB; Literature search: SG, NBM, LS, NB, YLS; Data collection: SG, YLS, NB; Data analysis: SG, YLS, LS, NBM; Draft manuscript: SG, NBM, LS, YLS, NB; Final manuscript and accountability: All

Acknowledgment

None

Conflict of interest

None

Funding

None

Supplementary material

The data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. Safiri S, Kolahi AA, Cross M, Carson-Chahhoud K, Almasi-Hashiani A, Kaufman J, et al. Global, regional, and national burden of other musculoskeletal disorders 1990-2017: results from the Global Burden of Disease Study 2017. Rheumatology (Oxford). 2021 Feb 1;60(2):855-65. DOI PubMed Google Scholar Full Text
2. GBD 2016 DALYs and HALE Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017 Sep 16;390(10100):1260-1344. DOI PubMed Google Scholar Full Text
3. Fitzgerald S, Barlow C, Kampert J, Morrow J, Jackson A, Blair S, et al. Muscular Fitness and All-Cause Mortality: Prospective Observations. J Phys Act Health. 2004 Jan; 1(1):7-18. DOI Google Scholar Full Text
4. Bohannon RW. Muscle strength: clinical and prognostic value of hand-grip dynamometry. Curr Opin Clin Nutr Metab Care. 2015 Sep;18(5):465-70. DOI PubMed Google Scholar Full Text
5. Pal G, Pal P, Nanda N. Nerve and Muscle. In: Comprehensive Textbook of Medical Physiology. 2nd ed. Jaypee Brothers Medical Publisher; 2019. p. 213–84.
6. Hall J, Hall M. Sports Physiology. In: Guyton and Hall Textbook of Medical Physiology. 14th ed. Philadelphia: Elsevier; 2021. p. 1073–84.
7. Sengupta S, Maity P, Pal P, Dhara PC. Effect of Body Posture on Hand Grip Strength in Adult Bengalee Population. Journal of Exercise Science and Physiotherapy. 2011;7(2):79–88. DOI Google Scholar Full Text
8. Desrosiers J, Bravo G, Hébert R. Isometric grip endurance of healthy elderly men and women. Arch Gerontol Geriatr. 1997 Jan-Feb;24(1):75-85. DOI PubMed Google Scholar Full Text
9. Doko I, Bajić Ž, Dubravić A, Qorolli M, Grazio S. Hand grip endurance moderating the effect of grip force on functional ability and disease activity in rheumatoid arthritis patients: a cross-sectional study. Rheumatol Int. 2019 Apr;39(4):647-656. DOI PubMed Google Scholar Full Text
10. Hossain MG, Zyroul R, Pereira BP, Kamarul T. Multiple regression analysis of factors influencing dominant hand grip strength in an adult Malaysian population. J Hand Surg Eur Vol. 2012 Jan;37(1):65-70. DOI PubMed Google Scholar Full Text
11. Koley S, Kaur N, Sandhu JS. A Study on Hand Grip Strength in Female Laborers of Jalandhar, Punjab, India. J Life Sci. 2009 Jul;1(1):57–62. DOI PubMed Google Scholar Full Text
12. Castellanos J, Axelrod D. Effect of habitual knuckle cracking on hand function. Ann Rheum Dis. 1990 May;49(5):308-9. DOI PubMed Google Scholar Full Text
13. Al-Obaidi S, Al-Sayegh N, Nadar M. Smoking impact on grip strength and fatigue resistance: implications for exercise and hand therapy practice. J Phys Act Health. 2014 Jul;11(5):1025-31. DOI PubMed Google Scholar Full Text
14. Kawamoto R, Ninomiya D, Senzaki K, Kumagi T. Alcohol Consumption is Positively Associated with Handgrip Strength Among Japanese Community-dwelling Middle-aged and Elderly Persons. Int J Gerontol. 2018 Dec 1;12(4):294–8. DOI Google Scholar Full Text
15. Al-Asadi JN. Handgrip Strength in Medical Students: Correlation with Body Mass Index and Hand Dimensions. Asian J Med Sci. 2018 Jan 1;9(1):21–6. DOI Google Scholar Full Text
16. Klein JW, Case TI, Fitness J. Can The Positive Effects of Inspiration Be Extended to Different Domains? J Appl Soc Psychol. 2018 Jan;48(1):28–34. DOI Google Scholar Full Text.
17. Oldfield R. C. (1971). The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia, 9(1), 97–113. DOI PubMed Google Scholar Full Text
18. Warburton DER, Jamnik V, Bredin SSD, Shephard RJ, Gledhill N. The 2019 Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+): 2019 PAR-Q+. Health Fit J Can. 2018 Dec 30;11(4):80–3. Google Scholar Full Text

19. Lee YL, Lee BH, Lee SY. Handgrip Strength in the Korean Population: Normative Data and Cutoff Values. Ann Geriatr Med Res. 2019 Dec;23(4):183-189. DOI PubMed Google Scholar Full Text
20. Bimali I, Opsana R, Jeebika S. Normative Reference Values on Handgrip Strength Among Healthy Adults of Dhulikhel, Nepal: A cross-sectional study. J Fam Med Prim Care. 2020 Jan 28;9(1):310–4. DOI PubMed Google Scholar Full Text
21. Miller AE, MacDougall JD, Tarnopolsky MA, Sale DG. Gender differences in strength and muscle fiber characteristics. Eur J Appl Physiol Occup Physiol. 1993;66(3):254-62. DOI PubMed Google Scholar Full Text
22. Herbst KL, Bhasin S. Testosterone Action on Skeletal Muscle: Curr Opin Clin Nutr Metab Care. 2004 May;7(3):271–7. DOI PubMed Google Scholar Full Text
23. Landi F, Calvani R, Tosato M, Martone AM, Fusco D, Sisto A, et al. Age-Related Variations of Muscle Mass, Strength, and Physical Performance in Community-Dwellers: Results From the Milan EXPO Survey. J Am Med Dir Assoc. 2017 Jan 1;18(1):88.e17-88.e24. DOI PubMed Google Scholar Full Text
24. Wang Y-C, Bohannon RW, Li X, Sindhu B, Kapellusch J. Hand-Grip Strength: Normative Reference Values and Equations for Individuals 18 to 85 Years of Age Residing in the United States. J Orthop Sports Phys Ther. 2018; 48(9):685-693. DOI PubMed Google Scholar Full Text
25. Kirchengast S, Huber J. Gender and Age Differences in Lean Soft Tissue Mass and Sarcopenia Among Healthy Elderly. Anthropol Anz. 2009 Jun 1;67(2):139–51. DOI PubMed Google Scholar Full Text
26. Canon ME, Crimmins EM. Sex Differences in the Association between Muscle Quality, Inflammatory Markers, and Cognitive Decline. J Nutr Health Aging. 2011 Oct;15(8):695–8. DOI PubMed Google Scholar Full Text
27. Baxi G, Tigdi R, Palekar T, Basu S, Sule K. Static and Dynamic Handgrip Endurance in Young Adults. Indian J Physiother Occup Ther - Int J. 2017 Jan 1;11(4):117. DOI Google Scholar Full Text
28. Das A, Dutta M. Correlation between Body Mass Index and Handgrip Strength and Handgrip Endurance Among Young Healthy Adults. J Evid Based Med Healthc. 2015 Jul 3;2(27):3995–4001. DOI Google Scholar Full Text
29. Maughan RJ, Harmon M, Leiper JB, Sale D, Delman A. Endurance Capacity of Untrained Males and Females in Isometric and Dynamic Muscular Contractions. Eur J Appl Physiol. 1986 Aug;55(4):395–400. DOI PubMed Google Scholar Full Text
30. Petrofsky JS, Lind AR. Aging, Isometric Strength and Endurance, and Cardiovascular Responses to Static Effort. J Appl Physiol. 1975 Jan 1;38(1):91–5. DOI PubMed Google Scholar Full Text
31. Chatterjee S, Chowdhuri BJ. Comparison of Grip Strength and Isomeric Endurance between the Right and Left Hands of Men and their Relationship with Age and Other Physical Parameters. J Hum Ergol (Tokyo). 1991 Jun;20(1):41–50. DOI PubMed Google Scholar Full Text