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IMPORTANCE OF HAND GRIP MEASUREMENT

ZNAČAJ MERENJA STISKA ŠAKE

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Abstract

The hand is the most important segment of the human body and the evolutionary pinnacle of human development. The preserved function of the hand is essential for the quality of life of the individual in everyday activities. The very importance of the hand is proven by the fact that the loss of function of the thumb leads to 40-50% damage to the upper limb, as a result of its central role in all grips and manipulative movements. Grips are divided to strong (oblique palm grip, ball grip, arched and cylindrical grip) and precise (pincer pinch, tip pinch, key pinch, palmar pinch). Reduced strength of a hand grip is a significant predictor of disability and reduction in the quality of life, and it is of great importance to establish norms and instruments to be used in hand grip strength measurements. Dynamometers are used to establish gross muscle strength and precise grips strength. Many works have been published regarding measurement of hand grip and precise grips, but there is still no uniform protocol for this. Besides the fact that the values obtained may assess the nutritional status of an individual, they are very important in early diagnosis, timely therapy and evaluation in clinical practice.

INTRODUCTION

Biomarkers are medical signs at the level of pathology, body function or structure, or activity/participation that provide an objective indication of health status. Grip strength, a measure of body function, has been proposed as a biomarker of aging [1]. The importance of the hand is proven by the fact that the loss of function of the thumb leads to 40-50% damage to the upper limb, as a result of its central role in all grips and manipulative movements. Grips give an objective picture of the function of the upper limb as a whole and may be divided into „precise" and „strong" ones (Table 1) [2]

Table 1. Grip types

Grips	Precise	Pincer pinch
		Tip pinch
		Key pinch
		Palmar pinch
	Strong	Oblique palm grip
		Ball grip
		Arch grip
		Cylindrical grip

By measuring the grip strength, the following can be established [3]:

• Total muscle strength

• Impairments in various musculoskeletal, neuromuscular, and cardiovascular or pulmonary conditions

• Potential adverse outcomes such as mortality and future disability.

Predictors of hand grip weakness

The loss of hand grip strength and the strength of precise grips represent a decrease in the overall functionality of the hand [4]. Reduced hand grip strength is associated with falls, disability, impaired quality of life due to poor health, and increased mortality. Various factors have been also identified in connection with the decrease in hand grip strength, namely age, low body mass index (BMI), reduced physical activity. Factors such as marital status, education level, health habits, and comorbidities have inconsistent effects on hand grip strength [5]. However, in a study by Celis-Morales et al. (2018), it was proven that people with the weakest hand grip have higher prevalence of smoking, obesity, and comorbidities, including cancer, diabetes, cardiovascular diseases, chronic diseases, depression, and hypertension. Also, people with a lower body height and a higher body mass index and waist circumference, as well as with a lower level of physical activity, were in the category of subjects with the weakest hand grip [6]. The age effect refers to changes in grip strength due to the aging process and accompanying changes in physiology, lifestyle and risk of disease [7].

People with a positive family history of osteoarthritis of the hand have a 15-fold higher chance of developing osteoarthritis and a 3-fold higher chance of suffering from metabolic syndrome [8]. More serious structural damage can lead to greater pain, functional limitations, work-related limitations, and dissatisfaction with the appearance of the hand [9].

Also, grip strength levels can change depending on the time period, which corresponds to calendar years. Finally, the period of birth can also be taken into account because people born in a similar time have similar historical and social characteristics [7].

Gross muscle strength

Manual dynamometer measures isometric force of the hand and forearm, providing a quick, easy and inexpensive method to assess grip strength and thus the nutritional status of patients (Figure 1) [10]. Dodds et al. reported that using different types of dynamometers has shown reasonably similar normative data within the same age categories [11]. There are variations in gross muscle strength (GMS) depending on race, gender and age, and it is necessary to establish standardized reference values. In general, men have higher GMS than women at all ages and GMS is higher in the right hand than in the left hand in both sexes [5].

Subject position

Sánchez Torralvo et al. (2018) conducted research in which measurements were performed with subject in a sitting position on a chair with flat backrest, with feet completely touching the floor. The shoulders were in a neutral position, and the elbow was bent by an angle of 90° without rotation. Three measurements were performed in the dominant arm with a rest period of at least one minute in between. The calculated mean value represented the hand grip strength [10]. In the research by Ler et al. (2018), the measurements were performed according to the Southampton protocol with the previously mentioned dynamometers, where the highest value measured for the dominant hand was taken as the grip strength. The subjects were also in a sitting position, with the forearms resting on the armrests of the chair [12]. Some authors reported that GMS was significantly higher when measured with 90 degrees of elbow flexion, while others report that GMS is higher with the elbow in full extension [13].

The American Society of Hand Therapists recommends sitting in a chair with a flat back, feet flat on the floor, shoulders in adduction and neutral rotation, elbow flexed at 90 degrees, forearm in neutral position, and wrist between 0 and 30 degrees of extension and between 0 and 15 degrees of ulnar deviation (Figure 2) [14]. In their study, Lim et al. (2019) measured gross muscle strength by having subjects look forward while standing upright with straight shoulders and arms freely falling at sides. Subjects did not bend their elbows or wrists and their hands did not touch the body. Subjects maintained this basic stance while grip strength was measured.

***Figure 1**: Hand-held dynamometer (private archive)*

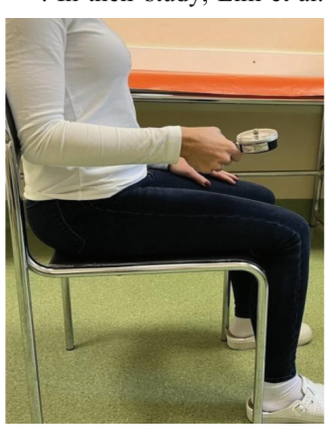

***Figure 2**: Procedure for gross muscle strength measurement (private archive)*

The examiner first measured the dominant hand with a 60- second break after the measurement. It was measured three times according to the same protocol [15]. Wrist position also affects GMS. For example, forearm pronation and wrist flexion were found to result in lower GMS values compared to the neutral position. It is interesting that the greatest GMS was measured with shoulder flexion of 180 degrees (i.e. arm above head) and elbow extended [14].

Reference values

An increasing number of studies report GMS reference values, but such generalization is hampered by variability in measurement instruments and protocols, differences between populations, and the use of nonrepresentative samples. The results of research in Brazil show that the mean values of GMS of the right and left hand were 42.4 and 40.6

kg in men, and 27.1 and 25.9 kg in women. In both men and women, the GMS of the right hand was greater than the GMS of the left hand [16] . In their research, Kim et al. obtained GMS values of the dominant hand of 18.5±6.77 kg in subjects aged 60-79 years [17]. Wiśniowska-Szurlej et al. (2021) report that GMS decreases with age in all age groups in both sexes. Thus, the average GMS of people aged 80-85 years was 17.97 kg (14.47 kg for women and 25.66 kg for men), and in the group over 85 years of age it was 16.68 kg (13.51 kg for women and 21.77 kg for men) [18]. Grip strength was highest in the 30-39 age group in men and in the 40-49 age group in women, when stratified by age, but was lowest in the over-70 age group in both sexes. The results of studies show that grip strength is higher in men than in women in every age category [15].

Reference values

Lam et al. (2016) also found in their results that men have higher precision grip strength values than women. Similarly as with GMS, the strength of precision grips decreased with age, while the highest was in the younger age categories [21] . A study by Rostamzadeh et al (2019) found the highest correlation of precision grip strength with forearm circumference. Tip pinch and key pinch were also correlated with palm width and wrist circumference, while palmar pinch strength was related to hand length, palm length and wrist circumference [23]. Vishwanath et al. (2021) obtained the strength values of all three precision grips, of which the key pinch was the strongest in subjects aged 20-40 years (right hand values 7.05 kg in men and 5.34 kg in women) [24]. However, Shaheen et al. (2021) results are

***Figure 3**: Tip pinch (private archive) Figure*

***Figure** 4: Key pinch (private archive)*

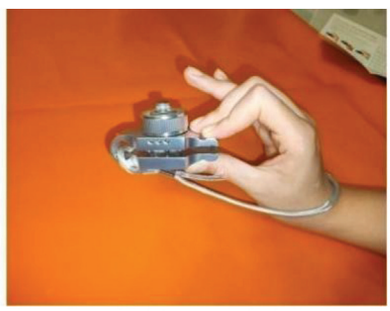

***Figure 5**: Palmar pinch (private archive)*

Precise grips

Precision grip force in the form of pinching plays an important role in the performance of everyday finger movements, including tip pinch, key pinch, and palmar pinch. A precise grip on an object is a complicated motor activity because a sufficiently large force must be used to prevent the object from slipping [19]. The sense and control of forces assume a complex role in the coordination of two or three fingers (thumb, index and middle finger) that are as involved in precise pinching grips [20].

Subject position

Lam et al. (2016) conducted a study in which subjects assumed a seated position with neutral shoulder position, elbow flexion of 90 degrees, wrist dorsiflexion of 0-30 degrees, and ulnar deviation of 0-15 degrees. First the strength of the non-dominant hand was measured, and then the strength of the dominant hand was measured in three measurements with a break between measurements of 10-20 seconds to avoid fatigue [21]. Souza et al. (2017) conducted a study in which they proved that fatigue affects the values of GMS and key pinch [22]. In the tip pinch, the fingertip of the thumb touches the fingertip of the index finger (Figure 3). In the key pinch, the fingertip of the thumb touches the lateral aspect of the middle phalanx of the index finger (Figure 4). The palmar pinch includes the fingertip of the thumb touching the fingertips of the index and middle fingers (Figure 5) [20]. Palm width, hand length and forearm circumference are shown to be the best predictors of hand strength even when compared to individual height and weight [23].

showing that the highest strength was found in the palmar pinch in subjects aged 19-25 years. The lowest difference between the dominant and nondominant hand (2.30 kg) was observed for 21-year-old subjects, while the highest difference (6.07 kg) was observed in 25-year-old women [25]. Vishwanath et al. (2021) compared the strength values of the right and left hands and found that the right hand is stronger than the left [24]. The results of studies show that gross muscle strength and precision grip strength decline with age [21] . The values of palm width, arm length, forearm and wrist circumference affect the strength of precision grips [23]. Fatigue is a predictor of weakness in gross muscle strength and precision grip strength [22].

CONCLUSION

Regardless of age, maintaining gross muscle strength and the strength of precise grips is a significant prerequisite for functionality, performance of activities in daily life and quality of life of people. New research is needed with homogenized groups of subjects, standardized instruments and method of execution, in order to establish reference values and measurement protocols as accurately as possible for adequate diagnostics, timely therapy and monitoring of therapeutic outcomes.

Sažetak

Šaka predstavlja najznačajniji segment ljudskog tela i evolucioni vrhunac razvoja čoveka. U svakodnevnim aktivnostima, očuvana funkcija šake održava kvalitet života pojedinca. Sam značaj šake dokazuje činjenica da gubitak funkcije palca šake dovodi do 40-50% oštećenja gornjeg ekstremiteta, kao rezultata njegove centralne uloge u svim hvatovima i manipulativnim pokretima. Hvatovi se dele na snažne (kosi dlanski, hvat lopte, lučni i cilindrični hvat) i precizne (pincet, trokraki, štipaljka i ključ hvat). Smanjena snaga stiska šake predstavlja značajan prediktor onesposobljenosti i smanjenja kvaliteta života ljudi, te je od velikog značaja utvrditi norme i instrumente na osnovu kojih se mogu vršiti merenja snage stiska šake. Za dijagnozu grube mišićne snage i snage preciznih hvatova koriste se dinamometri. Objavljeni su mnogi radovi o merenju stiska šake i preciznih hvatova, ali još uvek nema jedinstvenog protokola. Pored toga što dobijene vrednosti mogu proceniti nutritivni status pojedinca, veoma su bitne u ranoj dijagnostici, pravovremenoj terapiji i evaluaciji u kliničkoj praksi.

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