A Comprehensive Analysis of the Ergonomics of Hand Grip Strength using Gender, Hand Dominance and Wrist Position as Key Variables

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Abstract

Background and Objectives: The study of grip endurance is relatively underexplored, despite its significant practical implications in various fields. This research seeks to address this gap by investigating the impact of gender, hand dominance and wrist position on hand grip strength.

Materials and Methods: Hand grip strength was assessed in normal, flexed and extended wrist positions in both hands in 148 healthy right-handed individuals (58 females, 90 males) using a hand grip dynamometer and standard technique.
Results: The results revealed that hand grip strength was more in males and in dominant hand. Also, the hand grip strength was maximum in normal wrist position, followed by extended and flexed position.

Conclusion: These findings have clinical relevance for decisions regarding wrist pathology management, benefiting both surgeons and therapists. These findings endorse the routine use of grip strength either as a standalone measurement or as part of a comprehensive assessment battery for identifying adults at risk of poor health status.

Key Words: Grip strength, Wrist, Gender, Hand Dominance

Introduction

Grip strength has been researched as a predictor of functional performance and is influenced by a range of factors, including hand dominance, anthropometric measurements, and the positioning of the elbow, shoulder, and forearm [1-5]. Notably, the impact of wrist position on grip strength has been explored, both in the radioulnar and flexion-extension planes [6-9].

In addition to grip strength, grip endurance is a significant and relevant measure. In daily activities, individuals are more likely to employ sustained grip rather than maximum effort. However, there have been fewer studies examining grip endurance as a clinical indicator compared to studies on grip strength. Furthermore, limited research has addressed the influence of anthropometric and postural factors, including wrist position, on grip endurance. This scarcity of studies may be attributed to the absence of a standardized method for measuring grip endurance [10-15].

Various therapeutic interventions, such as wrist arthrodesis and the use of orthotic devices, play a crucial role in managing specific wrist conditions. Establishing the optimal wrist position at which both grip endurance and grip strength are maximized is essential for optimizing functional outcomes. Therefore, our study aimed to evaluate the impact of gender, hand dominance and wrist position in the flexion-extension plane on hand grip strength, utilizing a hand-held spring dynamometer.

Material and Methods

Prior ethical approval was obtained from the Institutional Ethics Committee. Written informed consent was duly acquired from all willing participants. A total of in 148 healthy right-handed individuals (58 females, 90 males) were enrolled in this study.

The study aimed to investigate the influence of hand positioning on grip strength, assessing it in three distinct positions: Normal, Flexed, and Extended. To gather various anthropometric data, specific measurements were taken: height was measured using a stadiometer, weight was recorded using a digital weighing machine,

and skeletal muscle strength was evaluated using a spring Hand Grip Dynamometer.

During the study, participants were seated in a specific posture, with their shoulder positioned at 0 degrees of abduction and in a neutral rotation, their elbow at a 90-degree flexion, and their forearm in a neutral position. Importantly, they were instructed to actively maintain this posture throughout the entire grip strength assessment process. To ensure consistency in the measurements, a single investigator conducted all experiments.

Grip strength was evaluated in a sequential manner for all participants across three different wrist positions. These positions included the unrestrained position, 45-degree extension, and 30-degree Flexion. To help participants adapt to using the dynamometer, they were initially asked to perform three submaximal contractions bilaterally. Afterward, with standardized verbal encouragement, they were directed to exert their best effort in gripping the dynamometer. The maximum grip strength (MGS) reading was recorded for both the right and left hands in the three wrist positions. To ensure participants' comfort and prevent fatigue, a one-minute rest period was provided between each measurement.

Results

Table 1 displays the anthropometric parameters of all study participants. There was no difference in these parameters when compared gender wise.

Table 1: Anthropometric parameters of study population

Parameter	Females (n=58)	Males (n = 90)	p Value
	Mean ± SD	Mean ± SD	
Age (in Years)	19.34 ± 1.74	19.72 ± 1.57	0.95
Height (in Centimeters)	156.6 ± 4.06	161.48 ± 4.16	0.56
Weight (in Kg)	57.66 ± 4.33	62.54 ± 4.42	0.61
BMI (Kg/m2)	23.55 ± 2.02	24.04 ± 2.16	0.86

Table 2 illustrates the gender-based differences in hand grip strength concerning hand and wrist positions. It was observed that grip strength was higher in males compared to females and also stronger in the dominant hand.

Table 2: Gender Variation in Hand Grip Strength

Hand and wrist position	Females (n=58)	Males (n = 90)	p Value
	Mean ± SD	Mean ± SD	
N-DH (Kg)	23.07 ± 5.38	37.34 ± 7.03	< 0.05
N-OH (Kg)	21.52 ± 5.87	34.85 ± 7.81	< 0.05
F-DH (Kg)	14.96 ± 4.12	23.95 ± 6.70	< 0.05
F-OH (Kg)	12.90 ± 4.38	23.85 ± 6.29	< 0.05
E-DH (Kg)	18.83 ± 4.91	27.12 ± 6.61	< 0.05
E-OH (Kg)	17.26 ± 4.16	25.90 ± 7.14	< 0.05

N = Normal wrist position, F = Flexed wrist, E = Extended wrist, DH = Dominant Hand, OH = Other Hand

Furthermore, the study found that hand grip strength was at its peak when the wrist was in normal position, followed by the extended and flexed positions, for both genders. Additional information can be found in Tables 3 and 4.

Table 3: Effect of wrist position on Hand Grip Strength (Females)

Hand	Wrist Position			p value
	Normal (Mean ± SD)	Flexed (Mean ± SD)	Extended (Mean ± SD)	
DH	23.07 ± 5.38	14.96 ± 4.12	18.83 ± 4.91	< 0.05
OH	21.52 ± 5.87	12.90 ± 4.38	17.26 ± 4.16	< 0.05

Table 4: Effect of wrist position on Hand Grip Strength (Males)

Hand	Wrist Position			p value
	Normal (Mean ± SD)	Flexed (Mean ± SD)	Extended (Mean ± SD)	
DH	37.34 ± 7.03	23.95 ± 6.70	27.12 ± 6.61	< 0.05
OH	34.85 ± 7.81	23.85 ± 6.29	25.90 ± 7.14	< 0.05

Discussion

Our study investigated the impact of wrist position on hand grip strength in a group of 148 healthy adults. We found that males had significantly greater grip strength than females, regardless of wrist position. This is consistent with the results of previous studies [16, 17].

We also found that grip strength was higher when the wrist was in a neutral position (neither flexed nor extended) compared to both the extended and flexed positions. The difference was most pronounced in the flexed position, where grip strength was about 20% lower than in the neutral position. This is also consistent with the findings of previous studies.Finally, we found that grip strength was greater in the dominant hand than in the non-dominant hand. This is likely due to the fact that the dominant hand is used more frequently and is therefore stronger [18-20].

These findings suggest that wrist position and hand dominance are important factors that can affect hand grip strength. When designing exercises or interventions to improve grip strength, it is important to consider these factors.

Conclusion

The findings of this study have clinical relevance for decisions regarding wrist pathology management by surgeons and therapists. By routinely assessing grip strength, either as a standalone measurement or as part of a comprehensive assessment battery, healthcare providers can identify adults who are at risk of these conditions and provide interventions to improve their health.

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