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Hand grip strength in dentists: A comprehensive evaluation of head position, dominance, age, and sex

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ABSTRACT

This study aimed to identify the effect of different head positions on hand grip strength (HGS) on account of hand dominance, age, and sex in dentists. A total of 197 dental students (DS) and practitioners (DP) (81 females and 50 males were DS, 10 females and 14 males were (DP) aged 19-63 participated. HGS was measured using a dynamometer, and the head angle was determined with an inclinometer. HGS on both sides was greatest in NHP & displayed least strength in HEP. There was a significant difference in HGS measured in NHP, HFP, and HEP ($p < 0.05$) for the dominant hand, while the non-dominant hand showed no significant difference ($p > 0.05$) for female DS. A significant difference was recorded between dominant and non-dominant HGS in each head position ($p < 0.05$). Significant differences were also found between female and male DP HGS ($p < 0.05$) and DS ($p < 0.05$), particularly at HFP and HEP. There was a significant difference noted between female DS and DP HGS, however, HGS for both dominant and non-dominant hands in DP was higher than DS in HEP ($p < 0.05$), while no significant difference noted for HFP and NHP. Females had the strongest grip in NHP, while males in HFP. HGS influenced by age; DP had stronger grip than DS. In a comparison between male and female DP and DS, males had stronger grip than females across all positions. Hand dominance significantly influences HGS, with the dominant having a stronger hand grip.

KEYWORDS

Head Position; Hand Grip Strength; Dominance; Dentists

1. INTRODUCTION

Hand applies three primary forms of force: gripping, pinching, and twisting. Among these forces, gripping has precise control of force and it is the most commonly employed (Liao, 2016). The gripping or hand grip strength (HGS) is an integral feature associated with the overall functional well-being of the hand, and it is defined as the ability to apply force to an object by forcing the fingers and thumb to work against the palm (Long et al., 1970). HGS is essential for the human body when performing prehensile and precise hand functions (Alahmari et al., 2017), and is considered in occupations as medical staff members who rely on the hand grip, especially dentists, since their field primarily involves the use of hands for examination and treatment, and who frequently execute repetitive operations requiring a high degree of pinch power and precision (Ding et al., 2013). Regarding mechanical pressure on the finger joints, the work duties in dentistry vary. When it comes to precise gripping, dentists mostly use their thumb, index, and middle fingers on their dominant hand, leaving their non-dominant hand free for supporting activities (Ding et al., 2013).

HGS has been widely used to assess the integrated performance of muscle grip strength in orthopaedics, rehabilitation, and ergonomics. Occupational ergonomists attempted to reduce or eliminate the exposure to physical exertion by redesigning work tasks and environments using strength data (Kong et al., 2011), it could be objectively measured using a Jamar dynamometer (Roberts et al., 2011), it is the gold standard tool for evaluation (Lee et al., 2020), and it was found to provide the most acceptable and accurate measurement of grip strength (Alahmari et al., 2017).

Research revealed the impact of neck position on hand grip strength. The research was conducted on young healthy adults and the best HGS results were obtained from the head-neck neutral position for both the left and right sides and revealed a statistically significant impact of head-neck positions on hand grip strength (Zafar et al., 2018).

Other investigations have confirmed that HGS is adversely connected with age and is substantially lower in women in the non-dominant hand, also Age groups above 65 had reduced HGS compared to age groups between 20, 34, 35, and 49 years, respectively. Age-related degenerative structural changes are the cause of this decline in hand function in the elderly, and it is frequently accompanied by pathological disorders such as rheumatoid arthritis or osteoporosis (Wollesen et al., 2020). According to another study measured Age-Related Changes in Grip strength, Aging-induced deterioration of hand grip strength might occur, and this results in poorer muscle strength and poorer bimanual coordination control by elderly people (Lee et al., 2020).

There are other various factors that could influence HGS, including gender, age, body mass index, occupation, upper-extremity muscular strength, and nutritional status (Carmeli et al., 2003; Sternäng et al., 2015). Numerous countries have published normative data on hand grip strength, typically categorized by age and gender (Bohannon et al., 2006; Angst et al., 2010). Hand grip strength by gender analysis shows that men have stronger grips at all ages, one reason for this difference in grip strength could be the different kinds of activities that each gender participates in (Oseloka et al., 2014). Males were shown to have greater overall strength than females due to variations in muscle mass generated by the male hormone testosterone, which boosts type II muscular fibres with high glycolytic enzyme activity (Griggs et al., 1989; Sinha-Hikim et al., 2006). When performing clinical work, as dentists may require awkward postures that bend forward and rotate their head, neck, and trunk to one side. which can cause strain on the body and increase the risk of injury. Among 147 dentists, 61% reported musculoskeletal disorders (MSDs) with a lower back pain prevalence of (30%) and neck pain of (30%) (Kumar et al., 2020).

Hence, we noticed that the strength of the hand grip may be affected by the position of the neck, and the people most affected are dentists. Therefore, the idea came to study: Is there a difference between students and dental practitioners? Also, can we describe to them and emphasize the correct position of the neck to give the greatest strength to the hand grip and reduce the effort that is required? Dentists do it at work.

The aim of this study is to investigate the effect of different neck positions on HGS in dentists on accounts of sex, as well as to find out if there was any significant difference between dominant and non-dominant HGS, as a trial to discover the ideal neck posture for dentists to have a stronger grasp and better performance.

2. METHODS

2.1. Study design and participants

This was a cross-sectional study. A total of 197 dental students and dental practitioners (81 females and 92 males were dental students, 10 females and 14 males were dental practitioners) between the ages of 19 and 63 participated in this study. The study was carried out at the Faculty of Dental Medicine, Umm Al-Qura University. All participants provided & signed informed consent, were informed about the study's purpose and methodology, and were given the option to withdraw at any time. They were also informed about the absence of any risks associated with the test. Inclusion criteria: dental students and dental practitioners; their ages ranged from 19 to 63 years. Exclusion criteria:

participants with cervical disc prolapses, traumatic neck pain, prior surgeries on the cervical region or upper limb, headaches, rheumatoid arthritis, orthopedic or neurological conditions, history of inflammatory joint disease in the upper quadrant of the body, cervical spondylosis, and improper head and neck posture were excluded.

2.2. Instruments

2.2.1. Bubble inclinometer

A reliable and cost-effective technology, the bubble inclinometer is lightweight and portable (Kolber et al., 2013), making it ideal for use in rehabilitation settings to evaluate the range of motion. This instrument features a circular face filled with fluid, including both coloured and transparent components. The movement of the fluid interface, influenced by gravity, is harnessed to measure motion accurately by aligning it with a rotating 360° dial (Hanks & Myers, 2023) (Figure 1).

Figure 1. Bubble inclinometer

2.2.2. Jamar hydraulic dynamometer

Is a small and portable piece of equipment that reads the grip force in both kilograms and pounds (Roberts et al., 2011), utilizing the Peak Hold Needle in basic recording, the Jamar device automatically retains the highest recorded value with a designated peak hold needle. The hand grip is efficient and comfortable, and these combined characteristics collaborate to guarantee accurate, reproducible results. In addition, grip strength may differ from person to person based on the size of the object being held. The examiner can measure grip strength for various-sized objects due to the adjustable handle (Fess, 1987), (Figure 2).

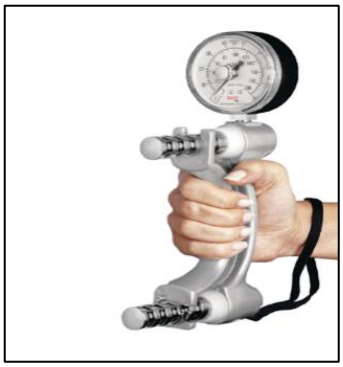

Figure 2. Jamar Hydraulic Dynamometer.

2.3. Procedures

The study procedure was explained to all participants, and data were collected from each participant. They were instructed to sit on a straight-backed chair with their feet flat on the floor, shoulders adducted, and elbows flexed at 90°, while keeping their forearms and wrists in a neutral position and free from the arm support. Hand grip strength was assessed from three different neck positions: neutral, flexion 30°, and extension 20°. An inclinometer device was positioned on the participants' heads along the sagittal plane (Sukari et al., 2021). Each participant was instructed to grip the dynamometer correctly, first with their dominant hand and then with their non-dominant hand. After that, the participant was instructed to exert maximum force on the dynamometer handle and maintain it for 5 seconds. This process was repeated with the participants in different neck positions (neutral, flexion 30°, and extension 20°) (Figure 3). To mitigate muscle fatigue, a one-minute rest period was enforced between each position (Ahmed, 2013). Throughout the experiment, participants were unaware of the dynamometer readings.

Figure 3. Measuring Hand grip strength from various head positions

2.4. Statistical analysis

Participants' demographic data as age, weight, height, as well as dominant hand variables were analyzed by using IBM SPSS software for Windows (version v20). Levine's test was used to test the homogeneity of variances. The comparison of HGS among different head positions for dominant and non-dominant hands in female students was carried out by using One Way ANOVA test, while the comparison of HGS between dominant and non-dominant hands in female dental students, comparison between female and male dental students HGS, and comparison between female dental students and practitioners HGS, all were carried out by independent sample t-test. The comparison between female and male dental practitioners for dominant and non-dominant HGS was carried out by Mann-Whitney U test. Results were expressed as mean ± standard deviation (M±SD). P values less than 0.05 were considered significant.

3. RESULTS

3.1. Demographic characteristics

A total of 197 dental students and practitioners (81 females and 92 males were students, 10 females and 14 males were dental practitioners) between the ages of 19 and 63 participated in this study. Demographic characteristics presented in Table (1).

Table 1. Demographic characteristics of all participants

Characteristics		Female students	Female practitioners	Male students	Male practitioners
Numbers		81	10	92	14
Age (years)		19.55 ± 2.65	49.2±9.51	22.2 ± 1.62	40.57±4.86
Height (cm)		159 ±6.84	161.2±4.59	173.85±6.23	172.43±4.54
Weight (kg)		59.95 ± 14.47	77.8±10.03	75.71±16.59	82±13.62
Dominant Hand	**Right**	76	10	90	14
	left	5	-	2	-

3.2. Effect of head positions

The ANOVA test was performed to test the effect of head positions on HGS. Table (2) shows the comparison of dominant and non-dominant HGS from various head positions of female dental students for each side separately. There was a significant difference in HGS measured from head neutral, flexion 30°, and extension 20° positions ($P < 0.05$) in the dominant hand. On the contrary, there was a non-significant difference in HGS in non-dominant hand between different head positions

(P > 0.05). However, HGS was greatest in the neutral head position and least strength in the extension head position.

Table 2. Comparison of dominant and non-dominant HGS from various head positions (NHP, HFP 30°, HEP 20°) in female dental students (effect of head position)

Variables	HGS in NHP (M±SD)	HGS in HFP 30° (M±SD)	HGS in HEP 20° (M±SD)	Mean difference	P value
Dominant hand	15.65 ±4.34	14.56±3.93	13.95± 4.03	F = 3.591	0.029
Non-Dominant hand	13.00 ± 4.15	13.25 ± 4.00	12.56 ± 4.22	F = 0.584	0.559

Note. HGS: *hand grip strength,* ***SD:*** *standard deviation,* ***NHP:*** *neutral head position,* ***HFP:*** *head flexion 30° position,* ***HEP:*** *head extension 20° position.*

3.3. Effect of hand dominance

Independent sample T-test was performed to test the effect of hand dominance on HGS. Table (3) shows the comparison between the dominant and non-dominant HGS in female dental students. There was a significant difference recorded between dominant and non-dominant HGS (P < 0.05) for each position separately; these differences were noted at neutral, flexion 30°, and extension 20° positions, Figure (4).

Table 3. Comparison between dominant and non-dominant HGS from various head positions (NHP, HFP 30°, HEP 20°) in female dental students (effect of hand dominance)

Variables	Dominant HGS M±SD	Non-Dominant HGS M±SD	T value	P value
NHP	15.65±4.34	13.00±4.15	3.98	0.000
HFP 30°	14.56±3.93	13.25±4.00	2.10	0.037
HEP 20°	13.95±4.03	12.56±4.22	2.15	0.033

Note: HGS: *hand grip strength,* ***M±SD:*** *mean±standard deviation,* ***NHP:*** *neutral head position,* ***HFP:*** *head flexion 30° position,* ***HEP:*** *head extension 20° position.*

3.4. Effect of gender

The Mann-Whitney U test and Independent Samples T-Test were performed to test the effect of gender on HGS. Mann-Whitney U test was performed to measure the difference between female and male dental practitioners of dominant and non-dominant HGS. There was a significant difference recorded between female and male HGS ($P < 0.05$); these differences were noted at flexion 30° and extension 20° positions, as shown in Table (4) HGS for male dental practitioners was higher than female dental practitioners in all head positions ($P <0.05$). Independent Samples T-Test was performed to measure the difference in HGS for dominant hands between female and male dental students from flexion 30° and extension 20° positions, there was a significant difference noted between male and female dental students HGS; however, as shown in Table (5) HGS for dominant hands in male dental students was higher than female dental students in all head positions ($P <0.05$). Figure (5).

Table 4. Comparison between dominant and non-dominant HGS from various head positions (HFP 30°, HEP 20°) in female and male dental practitioners (effect of gender)

Variables	Dominant HGS HFP 30°		Non-Dominant HGS HFP 30°		Dominant HGS HEP 20°		Non-Dominant HGS HEP 20°	
	Females	Males	Females	Males	Females	Males	Females	Males
Sum of ranks	55	245	53	244	71	229	59	241
Mean rank	5.50	17.50	5.45	17.45	7.10	16.36	5.9	17.21
Z value	-4.12		-4.11		-3.81		-3.88	
P value	0.000		0.000		0.001		0.000	
Significance	Significant		Significant		Significant		Significant	

Note. HGS: *hand grip strength,* ***M±SD:*** *mean ± standard deviation,* ***NHP:*** *neutral head position,* ***HFP:*** *head flexion 30° position,* ***HEP:*** *head extension 20° position.*

Table 5. Comparison between male and female dental students HGS for dominant hand from various head positions (HFP 30°, HEP 20°) (effect of gender)

Variables	Dominant HGS HFP 30°		Dominant HGS HEP 20°	
	Female students	Male students	Female students	Male students
M±SD	14.56±3.93	28.11±6.61	13.95±4.03	25.51±6.24
T value	16.60		14.65	
P value	0.000		0.000	
Significance	Significant		Significant	

Note. HGS: *hand grip strength,* ***M±SD:*** *mean±standard deviation,* ***NHP:*** *neutral head position,* ***HFP:*** *head flexion 30° position,* ***HEP:*** *head extension 20° position.*

3.5. Effect of age

Independent Samples T-Test was performed to measure the difference in HGS for both dominant and non-dominant hands between female dental students and dental practitioners from various head positions, Tables (6) and (7) showed that there was a significant difference noted between students and practitioners in HGS; however, HGS for both dominant and non-dominant hands in female practitioners was higher than female students in extension 20° head positions ($P < 0.05$). However, there was no significant difference noted in flexion 30° and neutral position.

Table 6. Comparison of dominant HGS from various head positions (NHP, HFP 30°, HEP 20°) between female dental students& practitioners (effect of age)

Variables	**Dominant HGS NHP**		**Dominant HGS HFP 30°**		**Dominant HGS HEP20°**	
	Students	Practitioners	Students	Practitioners	Students	Practitioners
M±SD	15.65±4.34	17.00±5.33	14.56±3.93	16.20±4.78	13.95±4.02	16.60±2.95
T value	0.902		1.22		2.01	
P value	0.369		0.226		0.047	
Significance	Non-significant		Non-significant		Significant	

Note. HGS: *hand grip strength,* ***M±SD:*** *mean±standard deviation,* ***NHP:*** *neutral head position,* ***HFP:*** *head flexion 30° position,* ***HEP:*** *head extension 20° position.*

Table 7. Comparison of non-dominant HGS from various head positions (NHP, HFP 30°, HEP 20°) between female dental students & female practitioners (effect of age)

Variables	**Non-Dominant HGS NHP**		**Non-Dominant HGS HFP 30°**		**Non-Dominant HGS HEP20°**	
	Student	Practitioners	Students	Practitioners	Students	Practitioners
M±SD	13.00±4.15	15.20±3.91	13.25±4.00	14.40±4.30	12.56±4.22	16.00±4.67
T value	1.59		0.853		2.41	
P value	0.115		0.398		0.018	
Significance	Non-significant		Non-significant		Significant	

Note. HGS: *hand grip strength,* ***M±SD:*** *mean±standard deviation,* ***NHP:*** *neutral head position,* ***HFP:*** *head flexion,* ***HEP:*** *head extension 20° position.*

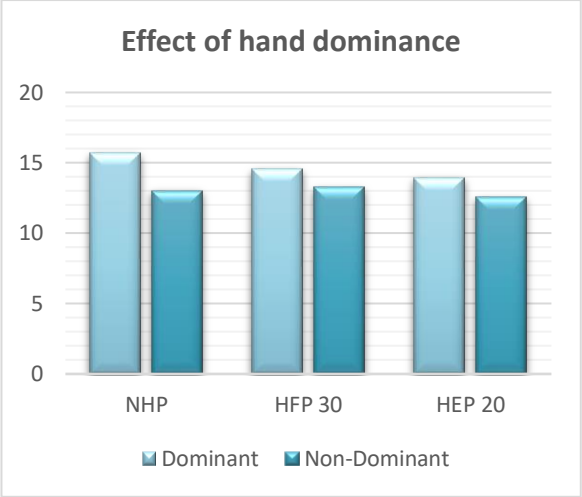

Figure 4. Comparison between dominant and non-dominant HGS from various head positions in female dental students. (Effect of hand dominance).

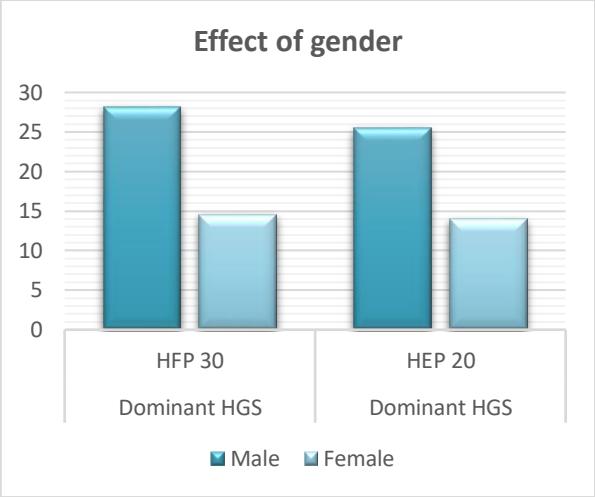

Figure 5. Comparison between dominant and non-dominant HGS from various head position in female and male dental students. (Effect of gender).

4. DISCUSSION

The findings of the present study indicated that among female dental students, the strongest grip strength of the dominant hand was observed in the head-neck neutral position, while the weakest grip strength was observed in the head-neck extension position for the dominant hand. These differences were found to be statistically significant. The findings of our study align with the conclusions drawn by Zafar et al. (2018), who also found that hand grip strength was greatest when the head-neck was in a neutral position. However, no statistical differences were found in the non-dominant hand grip strengths across different head positions.

Due to the synergistic effect of other muscles, the HGS evaluation in this study was conducted when the subject was seated, and the wrist was in a neutral position. This produced a strong grip strength. By avoiding wrist flexion, synergists can maintain the joint in a position where finger flexors can provide higher torque in addition to optimizing sarcomere length and moment arm length (Hillman et al., 2005). Additionally, El-Sais & Mohammad, (2016) reported that HGS decreases significantly in the prone position and is greatest in the standing position. This finding may help to explain the current findings, given that the HGS evaluation was conducted when the subject was set. In contrast to the current study, Kumar et al. (2012) reported the greatest assessment of grip strength while rotating the head-neck to the left. In a similar vein, Lee et al. (2010) found that in healthy people, head-neck rotation

posture resulted in somewhat superior grip strength than head-neck neutral position; unfortunately, the current study did not examine rotation of the neck and its effect on HGS.

The findings of the current study revealed significant disparities in HGS between dominant and non-dominant hands across various head positions, with HGS being highest in the dominant hand. This discrepancy in strength may be attributed to the frequent use of the dominant hand for everyday tasks (Habibi et al., 2013), resulting in the strengthening of its muscles and a subsequent increase in grip strength relative to the non-dominant hand.

Regarding the gender effect, the results of the current study conducted that male student exhibited significantly stronger HGS at dominant hand across all head positions compared to their female counterparts. Furthermore, male dental practitioners exhibited significantly stronger HGS for both dominant and non-dominant hands across all head positions compared to their female counterparts. The differences were most noticeable in flexion positions. The same findings were recorded by Jaafar et al. (2023), revealing that males display higher strength than females, potentially attributable to males having an average muscle mass approximately 10% greater than females. Another research proposed that due to differences in muscle mass produced by the male hormone testosterone, which increases type II muscular fibers with high glycolytic enzyme activity, males have been demonstrated to have better overall strength than females. As a result, men tend to exhibit stronger hand grip strength compared to women, owing to the physiological advantage conferred by testosterone-induced muscle development (Griggs et al., 1989; Sinha-Hikim et al., 2006).

The current study's findings also showed that, for both dominant and non-dominant hands, there were significant differences in hand grip strengths between female students and dental practitioners, particularly in extension positions. While no significant differences were seen in the flexion and neutral positions, female dental practitioners had considerably greater grip strength in the extension positions as compared to female students. Contrary to our findings, Eika et al. (2019) concluded a significant decline in hand grip strength with increasing age. When confronted with such disparities, it's essential to recognize that our study's limited sample size may contribute to these differences.

5. LIMITATIONS

The research encountered limitations in terms of practitioner participation, primarily stemming from the protracted process of securing permissions for collaborations with external facilities. Given the exclusive focus on practitioners affiliated with Umm Al-Qura University, the study confronted

challenges associated with their demanding schedules. Unfortunately, HGS from neutral position of male students and practitioners were not performed.

6. CONCLUSIONS

Various head positions had an impact on hand grip strength; females had the strongest hand grip in the neutral head position, while males in the flexion head position. The hand grip strength is also influenced by age; the dental practitioners had a stronger hand grip than students. In a comparison between male and female dental practitioners and students, the males demonstrated a stronger hand grip in all positions, indicating that gender has an impact on hand grip strength as well. Hand dominance also has an impact, statistics show a considerable difference in hand grip strength between dominant and non-dominant hands, with the dominant having a stronger hand grip.

7. RECOMMENDATIONS

Based on the results of the current study, it is recommended that the study be replicated with a larger sample of dental students and practitioners of various ages. Additionally, an assessment of handgrip strength (HGS) should be conducted from different elbow and wrist positions in relation to various head positions. Furthermore, measuring HGS in males in a neutral head position would provide valuable insights.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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