

Original Research

Study of hand grip strength and pinch grip strength among dental surgeons - an observational study

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ABSTRACT:

Background: Handgrip strength is a key indicator of an individual's health, physical stability, and surgical recovery, especially in older adults. The hand plays a vital role in dentistry and surgery, where grip strength and finger span are influenced by age and other factors. Dental professionals commonly use a pen grip, which, although precise, lacks ergonomic support. The pinch grip used in dentistry demands high muscle effort and provides limited stability due to the dual function of the middle finger, making it less suitable for prolonged use. **aimto** assess and compare hand grip and pinch strength among male and female dental surgeons. **Methods:** A total of 100 individuals was included in the study in which 50 male's and 50 females. Parameters wasinclude height, weight, BMI, hand length, arm span, thumb length, index finger length, middle finger length, hand grip strength and key pinch was measured in both genders. Hand parameters wasmeasured with the help of measuring tape and hand grip strength was measured by Jamar dynamometer and pinch strength was measured by using Jamar pinch gauge. **Results:** Males showed significantly higher values than females in all measured parameters, including thumb, index, and middle finger lengths, hand grip strength (46.68 ± 15.95 kg vs. 17.69 ± 8.49 kg), and key pinch strength (4.02 ± 1.4 kg vs. 3.25 ± 1.0 kg), with all differences statistically significant ($p < 0.05$). **Conclusion:** The study highlights notable gender differences in hand dimensions and strength. These findings emphasize the need for gender-specific ergonomic designs in dental instruments to improve comfort, efficiency, and reduce the risk of musculoskeletal disorders.

Keywords: Hand Grip Strength, Pinch Strength, Anthropometry, Dental Surgeons, Ergonomics, Musculoskeletal Disorders

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INTRODUCTION

Clinically, handgrip strength is an important factor that indicates the health of the individual and their physical stability; it even predicts general morbidity, problems after surgical procedure, and their outcomes in older people.¹The human hand has substantial significance in anthropometric studies, dentistry, and the field of surgery. The physiological characteristics of handgrip strength and finger span are influenced by a variety of circumstances.²

The length of one's finger and the strength of one's grasp vary as one gets older. In most cases a dentist or dental hygienist is using the pen grip for instrument manipulation, sometimes the palm grip.³The normal pen grip, by which a pen is held between the tips of the thumb and forefinger and the lateral side of the

distal (last) phalanx of the middle finger, is also used for handling dental instruments.⁴But this grip is unsuitable for use by dentists and dental hygienists. Because the used pinch grip requires much force of muscles of hand and upper arm while stability and flexibility are low as a consequence of using the middle finger for both holding the instrument and supporting the hand⁵.

Anatomically, the human hand is a highly complex structure that transmits crucial sensory information-such as temperature, shape, texture, and pressure-to the nervous system.⁶ Several studies have demonstrated a statistically significant difference in grip strength between dominant and non-dominant hands, consistently favoring the dominant hand.⁷ Hand anthropometry plays a vital role in enhancing

the efficiency, comfort, and usability of surgical tools and instruments.⁸ Instruments designed primarily for large male hands can be difficult to operate for individuals with smaller hands, particularly females. This mismatch can reduce performance and increase the risk of developing musculoskeletal disorders (MSDs).⁹ The design of hand tools directly influences upper-extremity posture, thereby contributing significantly to physical strain and fatigue.¹⁰ In medical fields, instruments are particularly important as they are directly connected to the surgeon's hands. Poorly designed tools can negatively impact posture and lead to muscular fatigue, pressure injuries, neurological damage, and early onset of tiredness.¹¹ It is essential to understand hand anthropometry specific to the target population when designing hand tools and other manual devices.¹² Dental professionals, such as dentists and dental hygienists, are especially prone to upper-extremity MSDs, including carpal tunnel syndrome. Proper ergonomic design of instruments is crucial to prevent such disorders.¹³ Among the various aspects of hand tool ergonomics, handle design is the most critical. Most existing research has focused on optimizing cylindrical handle diameters to improve performance, comfort, and reduce the risk of cumulative trauma disorders (CTDs) such as blisters, skin inflammation, and muscle cramps.¹⁴ The accuracy and usability of surgical instruments are significantly influenced by hand length. Surgeons with very small or large hands often struggle to grasp equipment handles designed without anthropometric considerations, forcing them to adopt suboptimal grip positions.¹⁵ Laparoscopic surgical instruments, in particular, are generally produced in standard sizes.¹⁶ Surgeons with smaller hands-especially women-frequently face difficulties operating oversized tools, particularly those requiring a power grip.¹⁷ Inadequate design of laparoscopic instruments often leads to localized muscle fatigue, especially in the forearm.¹⁸ There is an urgent need for consistent and ergonomic tool designs that consider both the shape and functional requirements.¹⁹

METHODOLOGY

The present study was conducted on a total of 100 individuals, equally divided into two groups based on

sex: males and females. Ethical clearance for the study was obtained from the Institutional Ethical Committee of Teerthanker Mahaveer Medical College and Research Centre Ref. No. (TMU/IEC/2023-24/03). Informed written consent was obtained from all participants prior to data collection. Participants were also briefed about the procedure and the purpose of the study. Basic demographic details, including name, age, sex, and region, were recorded. All measurements were taken on the dominant hand of each individual. The anthropometric and functional parameters assessed in this study included hand length, thumb length, index finger length, handgrip strength key pinch strength.

Statistical Analysis

Data were analyzed using SPSS software. Mean and standard deviation were calculated for all parameters. An independent t-test was used to compare values between male and female groups, with a p-value < 0.05 considered statistically significant.

1. Measurement of Hand length:

Measurements of the hand length were taken in both hands (perpendicular distance) from the tip of the middle finger to the distal wrist crease.²⁰

2. Thumb length:

Length was taken from the distal tip of the thumb to the first MCP joint.²¹

3. Index finger length:

Length was taken from the distal tip of the index finger to the second MCP joint.²²

4. Middle finger length:

Length was taken from fingertip to the third MCP joint.²³

5. Hand grip strength:

Grip strength is tested by placing the subject in seated position with his arm side, elbow flexed 90°, forearm in mid-prone position, wrist extended between 0°- 30° & ulnarly deviated 15° with the help of dynamometer.²⁴

6. Measurement of pinch strength:

It was measured with the help of pinch-gauge in the same position as tested the hand grip strength. Key pinch strength was measured by placing the pinch gauge in between the pad of the thumb and the lateral side of the middle phalanx of the index finger.²⁵



Figure 1: Hand length



Figure 2: Thumb length



Figure 3: Index finger



Figure 4: Middle finger length



Figure 5: Hand grip strength



Figure 6: Key pinch strength

RESULTS

This study the mean value of length from the distal tip of the thumb to the first MCP in male was 6.35 ± 0.48 , while the female was 5.34 ± 0.39 . the mean value of length was taken from the distal tip of the index finger to the second MCP joint in male was 6.069 ± 0.64 , while the female was 5.65 ± 0.62 . the mean value of the Length from fingertip to the third MCP joint in male was 7.30 ± 1.019 , while in female was

6.10 ± 1.344 . The mean value of the hand grip strength in male 46.68 ± 15.945 . While in female was 17.69 ± 8.49 . the mean value of the key pinch strength in male was 4.02 ± 1.4 while in female was 3.25 ± 1 . This table demonstrate the sexual dimorphism between males and females. And the results reveal that all the parameters of fingers in males and females were statistically significant.

Table 1: Showing the Comparative Overview of Ergonomic Parameters in Hand Tool and Surgical Instrument Design Based on Hand Anthropometry.

Parameters	Male Mean \pm S.D	Female Mean \pm S.D	p-value
Height(cm)	172.04 \pm 8.54	163.04 \pm 7.45	p<0.05
Weight (kg)	69.21 \pm 14.79	70.21 \pm 14.79	p<0.05
BMI	23.18 \pm 3.63	24.18 \pm 2.60	p<0.05
Thumb Finger	6.35 \pm 0.48	5.34 \pm 0.39	p<0.05
Index finger length	6.069 \pm 0.64	5.65 \pm 0.62	p<0.05
Middle Finger	7.30 \pm 1.019	6.10 \pm 1.344	p<0.05
Hand grip strength	46.68 \pm 15.945	17.69 \pm 8.49	p<0.05
Key pinch	4.02 \pm 1.4	3.25 \pm 1	p<0.05

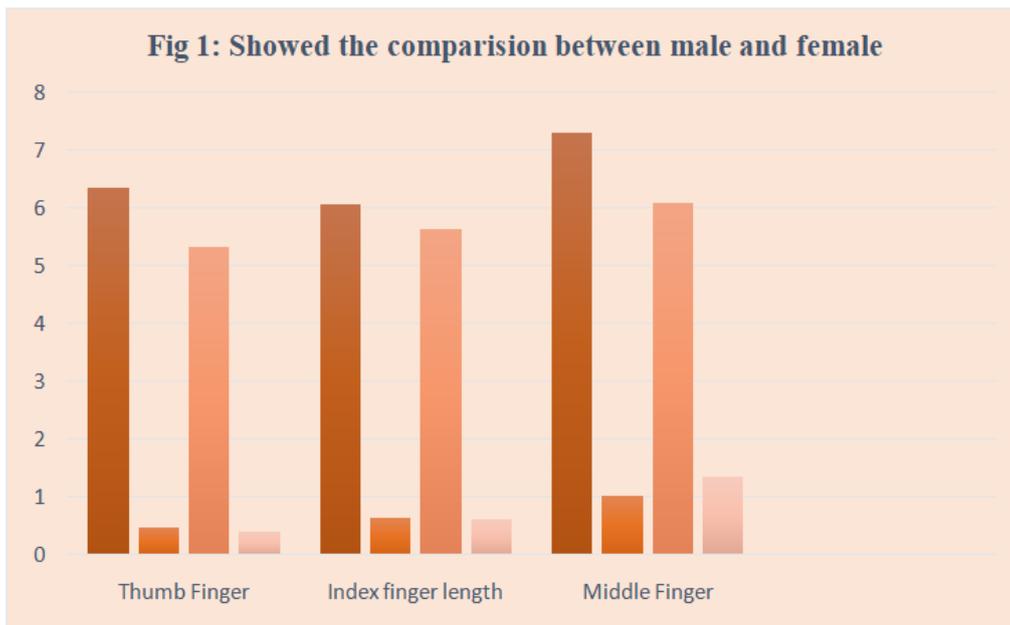


Figure 7: Comparison of thumb, index, and middle finger lengths between males and females, showing higher mean values in males across all parameters.

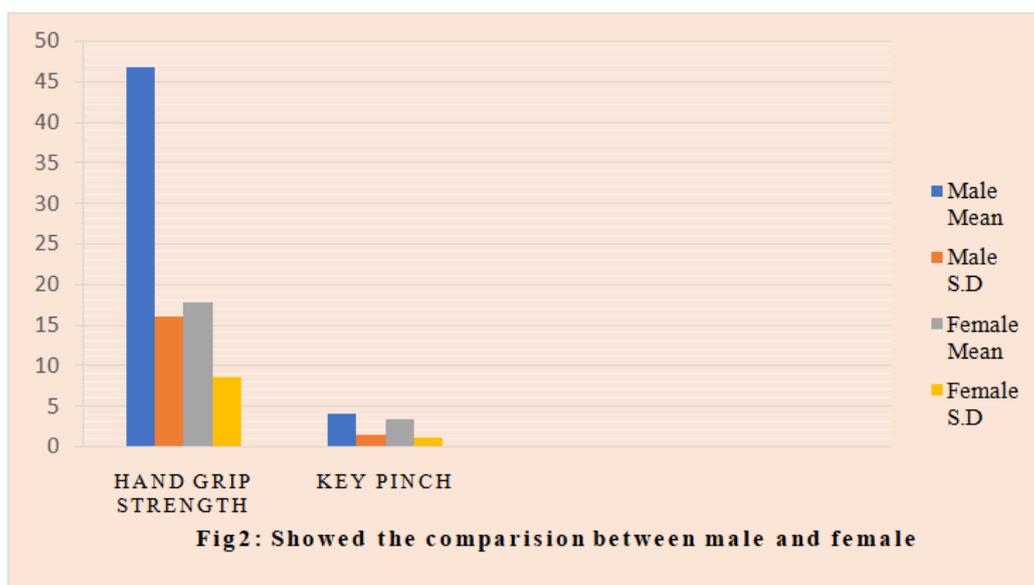


Figure 8: Comparison of hand grip strength and key pinch between males and females, with males showing higher mean values in both parameters.

DISCUSSION

In our study (Table 1), significant gender-based differences were observed in various hand anthropometric parameters and strength measurements. The mean thumb length (from the distal tip to the first MCP joint) in males was 6.35 ± 0.48 cm, whereas in females it was 5.34 ± 0.39 cm. The mean index finger length (from the distal tip to the second MCP joint) was 6.07 ± 0.64 cm in males and 5.65 ± 0.62 cm in females. The middle finger length (from the distal tip to the third MCP joint) averaged 7.30 ± 1.02 cm in males and 6.10 ± 1.34 cm in females.

The mean hand grip strength was significantly higher in males (46.68 ± 15.95 kg) compared to females (17.69 ± 8.49 kg). Similarly, key pinch strength was also greater in males (4.02 ± 1.4 kg) than in females (3.25 ± 1.0 kg). All these differences were statistically significant ($p < 0.05$).

Our findings are consistent with those reported by **Cakit et al.**²⁶ in a study of Turkish dental students, where males exhibited longer finger lengths and higher grip strength values than females. For example, male thumb length was 7.45 ± 0.58 cm, while in females it was 6.34 ± 0.49 cm; male middle finger length was 8.30 ± 2.02 cm compared to 7.10 ± 2.46 cm in females.

Chatzioglou et al.²⁷ also reported significant differences in finger lengths between sexes and between right and left hands ($p < 0.05$). Similarly, **Hajaghazadeh et al.**²⁸ and **Jee et al.**²⁹ confirmed that males typically possess larger hands than females, with male hand dimensions exceeding female dimensions by 3.73% to 14.25%.

In terms of strength, **Cakit et al.**²⁶ observed significantly higher grip and pinch strengths in males across different countries, including Britain, Malaysia, and Israel. These differences were statistically significant, suggesting both anatomical and cultural variations may influence hand strength metrics.

CONCLUSION

The present findings revealed that females exhibited significantly lower values in various hand parameters—including thumb length, index finger length, middle finger length, hand grip strength, and key pinch, when compared to their male counterparts. These observed anatomical and functional differences underline the importance of considering gender-specific variations in the ergonomic design of surgical instruments.

Traditional one-size-fits-all approaches in surgical tool manufacturing fail to accommodate the unique hand anthropometry of female users, potentially leading to decreased operational efficiency, increased fatigue, and a higher risk of musculoskeletal disorders. Therefore, integrating these baseline anthropometric values into the design process is essential for creating ergonomically optimized instruments that cater to both male and female surgeons.

By aligning instrument dimensions and mechanical demands with user-specific characteristics, especially hand size and strength, it becomes possible to enhance user comfort, reduce physical strain, and ultimately improve the precision, safety, and overall quality of surgical outcomes. These findings advocate for a more inclusive and evidence-based approach to medical equipment design, ensuring improved performance across diverse user populations.

Clinical Implications: Mismatch in tool size can lead to overuse injuries like carpal tunnel syndrome and early fatigue, affecting procedural precision. Gender-specific ergonomic tools can reduce musculoskeletal disorders, improve posture, and enhance the professional longevity of dental practitioners.

Limitations: The study had a small sample size and was limited to a single institution, which may affect generalizability. Only key pinch strength was assessed; other grip types like lateral and tripod pinch were not evaluated.

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