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Original Article

The effect of non-pathological neck pain on hand grip strength in healthcare practitioners across three different head positions: a cross-sectional study design

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Abstract. [Purpose] To determine how different head-neck positions (HNPs) influence the hand grip strength (HGS) of medical personnel with non-pathological neck pain (NPNP). [Participants and Methods] A cross-sectional study recruited 46 healthcare professionals: 21 (45.7%) with NPNP and 25 (54.3%) without. A dynamometer, cervical range of motion, and visual analogue scale measured HGS, HNPs, and NPNPs. Participants were instructed to squeeze the handgrip dynamometer handle in 90-degree elbow flexion as much as possible from a seated position to measure HGS from the neutral head position (NHP), 40° head neck flexion (HFP40°), and 30° head neck extension (HEP30°). [Results] The mean HGS for the dominant hand in NHP, HFP40°, and HEP30° was 29.27 kg (± 9.03), 27.24 kg (± 9.08), and 26.37 kg (± 9.32), while for the non-dominant hand it was 27.45 kg (± 9.62), 25.23 kg (± 9.36), and 24.61 kg (± 10.17). There was no significant correlation between HNPs and HGS. However, the only significant difference was between dominant HGS in the NHP and non-dominant HGS in the HEP30°. [Conclusion] NPNP had no significant influence on HGS in any of the three HNPs for either hand. Future studies should include other HNPs and other potential variables such as age, gender, weight, and pain intensity.

Key words: Non-pathological neck pain, Head-neck positions, Hand grip strength

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INTRODUCTION

Non-pathological neck pain (NPNP) is neck pain that occurs in the absence of a specific underlying medical condition or injury[1)]. Non-pathological neck pain can reduce hand grip strength (HGS), but not as significantly as those with specific pathological conditions[2, 3)].

As a result of the COVID-19 epidemic, the incidence of neck pain has increased dramatically[3)]. Some factors related to COVID-19 contributed to NPNP. Changes in lifestyle and work environment, increased screen time, reduced physical activity, stress and anxiety, and limited access to healthcare services may increase pressure on the neck and its surrounding muscles and cause NPNP[2, 3)].

NPNP can lead to muscle tension and discomfort in the neck and surrounding regions[1–3)]. The muscles in the neck, shoulder, and upper extremities are interrelated[3, 4)]. Excessive muscle tension in the neck can impact the strength and function of the hands and grip[4)]. NPNP can lead to muscle guarding and reduced mobility as a result of pain and discomfort. Changes in muscle recruitment patterns and restricted movement can result in a reduction in HGS[3–5)].

HGS refers to the force generated by the muscles in the hand and forearm while grasping an object[6, 7)]. It was considered a key indicator of upper-body strength and overall physical fitness[6, 7)]. However, HGS can vary based on factors such as age,

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gender, overall muscle strength, and physical well-being[8, 9]. Exercise, nutrition, and underlying medical conditions can also impact HGS[8–10].

HGS was commonly assessed using a hand dynamometer to determine the maximum force produced during a static grip[11]. The person firmly grips the dynamometer. The device measures force in pounds or kilogrammes[11]. HGS is important in sports performance, occupational health, and rehabilitation. It was frequently used as an indicator of overall strength and functional ability[11].

Researchers demonstrated that there is a significant relationship between NPNP and upper limb functionality, particularly HGS[11, 12]. NPNP can affect HGS by providing difficulty in holding objects securely, resulting in decreased HGS[13]. Additionally, NPNP can cause muscle weakness and imbalances in the neck and shoulder regions, which can reduce HGS by weakening hand and finger muscles[14]. Furthermore, NPNP may restrict shoulder and neck motion. Reduced neck mobility might affect hand and finger movement as well as posture. HGS and fine motor control might be difficult with a limited range of motion[15]. In general, difficulties with gripping, grasping, and manipulating objects can arise due to pain, weakness, or a limited range of motion. These limitations can directly affect HGS and overall upper limb functionality[11, 13–15].

A cross-sectional study conducted during the chronic period following a stroke, handgrip strength correlates strongly with arm muscular strength[16]. This study revealed that a person's ability to grasp objects might be indicative of overall muscle weakness in the upper extremities during the chronic phase following a stroke[16]. Another study, a randomized controlled study, showed that HGS and muscle strength were 20–30% lower on the painful side than on the other side[17]. Authors concluded that the head-neck position might play a role on the HGS[17].

Proper head and neck position, in addition to maintaining proper posture, can improve performance and reduce the chances of discomfort or injury while engaging in HGS.A debate arose regarding the influence of head and neck positions on HGS[18, 19].

A cross-sectional study examined the impact of various head-neck positions on the HGS of healthy young adults[19]. Study findings showed that keeping the head and neck in a neutral position while rotating them to the right results in the strongest HGS[19]. Another study found that the strongest HGS was achieved when the head and neck were oriented to the left[18]. However, there was no indication that the head and neck position should be considered when assessing HGS[18].

Numerous investigations have shown the difference in HGS between the dominant and non-dominant hands. Findings showed that the dominant hand grips 10% to 25% stronger than the non-dominant hand[20]. However, individuals' age, gender, and fitness can affect this variation. Other findings reported that the dominant hand was stronger than the non-dominant hand. Males' HGS was most correlated with weight and height, while females' HGS was most correlated with weight and BMI[21, 22]. The effect of head and neck positions on HGS in these studies was missed.

To identify the effect of the neck position on the HGS, one study found that applying Kinesio tape to the dominant hand significantly increased its HGS in a neutral head position compared to when the hand was not taped and the head was rotating[23]. Another study found that healthy volunteers who played virtual reality games had greater HGS in their non-dominant hand when their heads were in neutral positions[24]. However, some researchers have investigated and discovered no evidence of these alterations[25].

Insufficient research exists on how different head and neck positions affect HGS (HGS) in healthcare professionals with neck pain, creating a knowledge gap on such an issue among healthcare professionals. This study is essential due to the recognised significance of HGS for hand functions and its relevance for professions like medical personnel that rely largely on HGS. Therefore, the purpose of the study was to determine whether there was a statistically significant difference between dominant and non-dominant HGS in various head positions among medical professionals with and without NPNP.

PARTICIPANTS AND METHODS

This study used a cross-sectional design. There were a total of 46 medical staff members involved in this study. Figure 1 demonstrates the method of data collection.

Any medical professional without neck pain or with NPNP met the inclusion criteria. Neurological disorders, headaches, cervical region or upper limb surgery, traumatic neck pain, rheumatoid arthritis, cervical disc prolapses, cervical spondylosis, and vertigo were excluded from participation. The research ethics committee at the University of Tabuk granted ethical approval (UT-89-08-2023). Each participant provided written informed permission, indicating their voluntary choice to participate in the study and their awareness that they might withdraw at any time without facing any negative repercussions. Recruitment took place between September 2023 and December 2023.

The study was carried out in three main hospitals in Tabuk City, Saudi Arabia. Each hospital was formed by several medical departments. The first stage in gaining the trust and involvement of the medical departments was to spend some time getting to know the administrators of those departments and to explain the goal of the research. In the 28 invitation letters issued to various medical departments within the geographical recruiting goal zone, individuals were invited to participate in this study. There were six medical departments that expressed interest in participating.

In the initial instance, the study project was introduced to the staff of the possible participants through a rolling program in each department. This was done to include as many individuals as possible. This included a 15-minute presentation by the researcher explaining the study and the nature of participation, followed by an opportunity for questions. At least seven

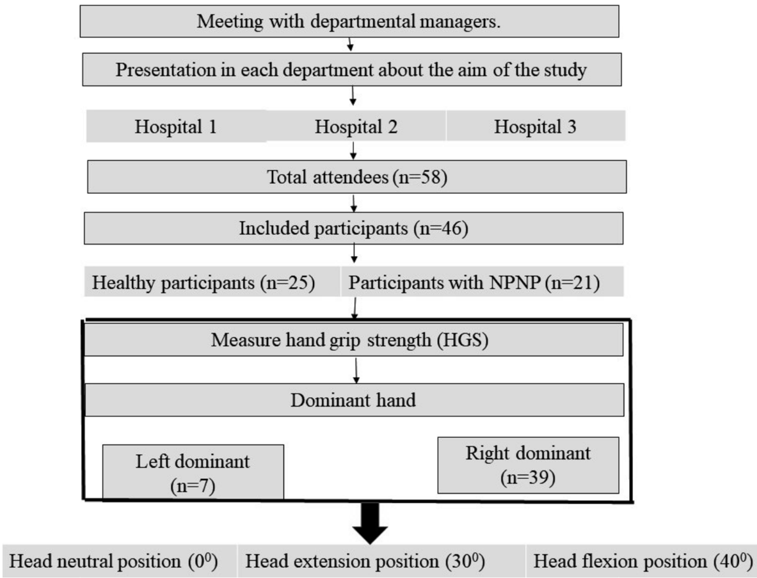

Fig. 1. The data collecting approach.

and no more than twenty-five employees from the three main health institutions in Tabuk city, Saudi Arabia, rotated through 15-minute sessions between September and December 2023. To ensure that all medical personnel had the opportunity to participate, the schedule of presentations to describe the study topic and generate interest was designed to be flexible. The majority of attendees were registered physiotherapists, nurses, occupational therapists, and dentists, although other professions were also welcome. The presentation-rolling program was attended by around 58 medical staff from the three participating health institutions.

After the introductory sessions concluded and the department managers were contacted, they reported that their employees' interest was obvious during the subsequent presentations and question-and-answer sessions. Everyone who expressed interest in participating was sent informational letters and a consent form. Forty six medical professionals expressed interest in participating in this research. Participants received detailed information about the research objectives, methods, potential hazards, and benefits before taking part. Each participant provided written informed permission, indicating their voluntary choice to participate in the study and their awareness that they might withdraw at any time without facing any negative repercussions.

A visual analogue scale (VAS) is a pain evaluation instrument consisting of a straight line ranging from zero to 10, with zero signifying the perfect absence of pain and ten representing the most severe pain imaginable[26)]. The patient was advised to place a point on the line based on their level of pain.

The Jamar hydraulic hand dynamometer (JHHD) offers several features, including routine, screening, and hand strength evaluation[27)]. Typically, the JHHD indicates the holding force in pounds and kilograms (200 pounds or 90 kilograms)[27)]. Maximum holding force needle for simple recording, the JHHD's peak hold needle maintains the highest reading. This reading remained until the examiner recalibrated the scale. The combination of the hand grip's efficiency and comfort guarantees accurate, dependable results. Depending on the size of the object being gripped, grip strength might vary amongst individuals. The handle is interchangeable, allowing the examiner to assess grip strength on objects of various sizes (Fig. 2a). Cervical range of motion (CROM): The CROM evaluates cervical flexion, extension, lateral bending, and rotation[27)]. Three hinges were attached to the frame of an eyeglass-like device: one in the sagittal plane for flexion and extension, one in the frontal plane for side bending, and one in the horizontal plane for rotation. Two of these inclinometers utilize a gravity-driven needle in the sagittal and frontal planes, while the third employs a magnetic needle in the horizontal plane. The patient wears a magnetic cervical collar. The frontal plane gravitational inclinometer monitors side bending is user-friendly and is reasonably priced (Fig. 2b).

Each participant was instructed to sit on the chair with their lower back supported, feet flat on the ground, shoulder adducted, elbow flexed to 90 degrees, and wrist joint in the middle position. The individual was instructed to grasp the JHD with the CROM dial set to 0° while the CROM was worn over the head. The JHD was used to measure HGS in three head-neck positions: neutral, flexion at 40°, and extension at 30° (Fig. 3).

The JHD was held initially with the dominant hand and then with the nondominant hand. In order to measure grip strength on the JHD, the participant was instructed to squeeze as tightly as possible for five seconds. The same movement was performed in three different neck positions: neutral, 40° of flexion, and 30° of extension. The individual's maximal grip strength was measured in kilograms (kg) by producing maximum force while being verbally encouraged. No one knew what

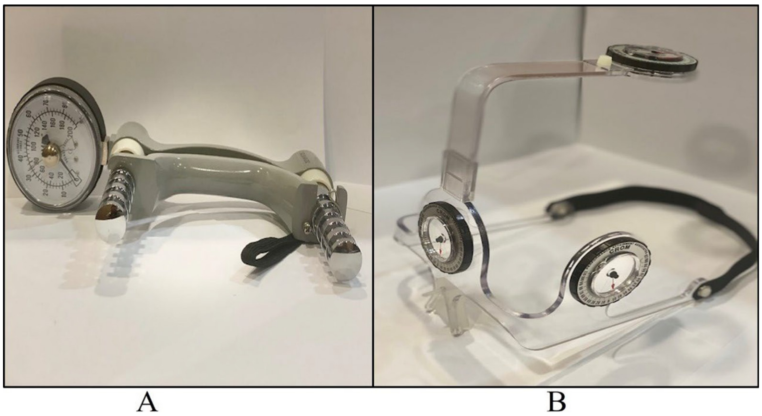

Fig. 2. Data collection tools employed in the study; (A), a Jamar hydraulic hand dynamometer was used to collect hand grip strength (HGS) data. (B), the cervical range of motion (CROM) was positioned on the nasal bridge and ears and secured to the head with a Velcro strap.

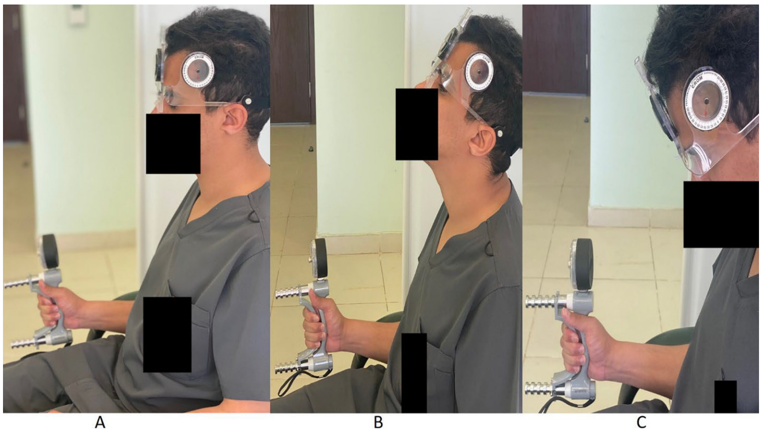

Fig. 3. The various hand grip strength (HGS) measurements in three different neck positions: A, when the neck was in a neutral position; B, when the neck was extended (30°), and C, when the neck was flexed (40°).

the dynamometer data indicated; therefore, the average of three head-neck measurements was collected with a one-minute break between each attempt to prevent fatigue.

For each head position, the data for dominant and nondominant HGS were presented as the mean (M) and standard deviation (SD). The data exhibited a normal distribution, according to the Shapiro–Wilk test. Levene's test revealed that the grip strength of both hands was homogenous. The HGS of dominant and nondominant hands in relation to the three head positions was compared using a one-way ANOVA. The Bonferroni test was used to determine whether there were statistically significant differences in the mean values of HGS (kg) for each head position in the dominant and non-dominant hands, as well as between the HP and those with NPNP. The Statistical Package for Social Studies (SPSS) version 25 for Windows (IBM SPSS, Chicago, IL, USA) was used for data analysis. The significance level for all statistical tests was set at $p<0.05$.

RESULTS

Forty six participants were recruited, consisting of 29 males (63%) and 17 females (37%). Only 7 individuals (15.2%) showed left-handed dominance (LHD), while 39 participants (84.8%) had right-hand dominance (RHD) (Table 1).

HGS was greatest on both sides (dominant and non-dominant) when the head and neck were in a neutral position (Table 2). The weakest HGS was measured in the head-neck extension position on both sides. When the head and neck were in neutral, flexion (40°), and extension (30°) postures, there was no difference between the dominant and nondominant hands on either side for HGS ($p>0.05$) (Table 2). When dominant and non-dominant HGS from different head positions were compared, it was found that there was a significant difference ($p=0.021$) between them (Table 2).

An ANOVA was carried out to determine which groups vary from one another. The results revealed a significant difference between dominant HGS in the neutral head position and non-dominant HGS with head extension (30°) (p=0.018). (Table 3).

Concerning the effect of NPNP on HGS, the ANOVA test was also performed to evaluate if there was a significant difference between the dominant HGS in healthy medical personnel and in medical personnel with NPNP at different head positions. However, the results were not statistically significant (p=0.325). (Table 4).

Table 1. Demographic characteristics of the participants

Variables		Number (%)
Gender	Male	23 (50%)
	Female	23 (50%)
Age (years)	25–30	14 (31.4%)
	31–40	18 (38.4%)
	41–50	8 (17.4%)
	>50	6 (12.8%)
Area of practice	Physiotherapists	12 (26.7%)
	Nursing	17 (37.2%)
	Occupational therapists	9 (19.8%)
	Dentist	5 (10.5%)
	Others	3 (5.8%)
Hand dominant	Right	39 (84.8%)
	Left	7 (15.2%)
Healthy participants		25 (54.3%)
Participants with non-pathological neck pain (NPNP)		21 (24.4%)

Table 2. The effect of different head positions on dominant and non-dominant hand grip strength (HGS) (Mean)

Positions	Dominant hand (mean ± SD)*	Non dominant hand (mean ± SD)*
NHP (0°)	29.27 ± 9.03	27.45 ± 9.62
HFP (40°)	27.24 ± 9.08	25.23 ± 9.36
HEP (30°)	26.37 ± 9.32	24.61 ± 10.17

*p<0.05. SD: standard deviation; NHP: neutral head position; HFP: head flexion position; HEP: head extension position.

Table 3. Comparison between all hands grip strength from different head positions for both; dominant and non-dominant hands

Hand	Measurements	Mean
Dominant	HGS with NHP (0°) & HFP (40°)	2.03
	HGS with NHP (0°) & HEP (30°)	2.90
	HGS with HFP (40°) & HEP (30°)	0.87
Non-dominant	HGS with NHP (0°) & HFP (40°)	2.22
	HGS with NHP (0°) & HEP (30°)	2.84
	HGS with HFP (40°) & HEP (30°)	0.62
Dominant and non-dominant	Dominant HGS with NHP (0°) & Non-dominant HGS with NHP (0°)	1.82
	Dominant HGS with NHP (0°) & Non-dominant HGS with HFP (40°)	4.04
	Dominant HGS with NHP (0°) & Non-dominant HGS with HEP (30°)	4.66*
	Dominant HGS with HFP (40°) & Non-dominant HGS with NHP (0°)	−0.21
	Dominant HGS with HFP (40°) & Non-dominant HGS with HEP (30°)	2.63
	Dominant HGS with HFP (40°) & Non-dominant HGS with HFP (40°)	2.01
	Dominant HGS with HEP (30°) & Non-dominant HGS with NHP (0°)	1.08
	Dominant HGS with HEP (30°) & Non-dominant HGS with HFP (40°)	1.14
	Dominant HGS with HEP (30°) & Non-dominant HGS with HEP (30°)	1.76

*p<0.05. HGS: hand grip strength; NHP: neutral head position; HFP: head flexion position; HEP: head extension position.

Table 4. Effect of different head positions on dominant HGS (kg) between healthy participants and participants with NPNP

Positions	Healthy HGS (mean ± SD)	NPNP HGS (mean ± SD)
NHP (0°)	29.27 ± 9.03	27.13 ± 7.49
HFP (40°)	27.24 ± 9.08	25.62 ± 7.09
HEP (30°)	26.37 ± 9.32	25.18 ± 7.38

SD: standard deviation, HGS: hand grip strength, NHP: neutral head position; HFP: head flexion position; HEP: head extension position; NPNP: non pathological neck pain.

DISCUSSION

The primary objective of this study was to evaluate how NPNP influences the HGS of healthcare practitioners when the participants were in a variety of different head positions. Furthermore, to find out if there is a statistically significant difference between dominant and non-dominant HGS in various head positions among medical professionals who have NPNP and those who do not have this type of pain.

The current study revealed that the HGS on both sides (dominant and non-dominant) was greatest in the head-neck neutral position and lowest in the head-neck extension position; however, these values were not statistically significant. The findings of this study corresponded with the conclusion reached by Zafar et al., which stated that the maximum HGS was found when the head and neck were in a neutral position[19)]. However, in contrast to this study's findings, another study indicated that maximal grip strength was reached when the head and neck are inclined to the left[18)]. Further investigation revealed a lack of empirical evidence that supports the claim that maximum grip strength occurs when the head and neck are inclined to a specific position. However, the optimal position to increase grip strength can vary across individuals due to their unique anatomical characteristics, strength of muscles and coordination in the hand, forearm, and upper arm, hand size, and variations in neuromuscular function[28, 29)]. The discrepancy between these results may indicate that further study is required to examine the relationship between HGS and neck pain, taking into consideration additional demographic, occupational, and lifestyle characteristics[8–10)].

In this study, the HGS was evaluated when the participant was sitting and the wrist joint was in a neutral position. This resulted in a powerful hold as a result of the synergistic actions of other muscles. By preventing the wrist from flexing, synergists can maintain the joint in a posture that maximizes the length of the sarcomere and the length of the moment arm[30)].

Sitting position provides stability and facilitates regular assessment of individuals' grip strength. Sitting additionally helps in minimising the involvement of other muscle groups, especially those in the lower body, which may have an effect on the results[30, 31)]. Furthermore, it is customary to position the wrist joint in a neutral position when evaluating grip strength. By keeping the wrist in a neutral position, the muscles that contribute to grip strength are efficiently engaged, and the measurement is specifically focused on the muscles of the hand, forearm, and upper arm[30, 31)]. Other findings revealed that there was no noticeable difference between the various arm positions; hence, the clinician is free to conduct the HGS test from any position that is appropriate[28, 32)].

The results of this study revealed that there were no statistically significant differences in hand grip strength (HGS) between the dominant and non-dominant hands among individuals in three different head-neck positions (NHP, HFP40°, and HEP30°). The result of this study may indicate that there was no evidence that the positions of the head and neck should be taken into consideration. It is probable that the results of this study were attributable to the fact that all of the participants were working in different capacities, and that the nature of their occupations and the patient caseloads they were responsible for varied, which may influence the HGS.

There were no statistically significant differences in HGS between individuals with or without NPNP in the current study. This may be due to the fact that none of the participants had neurological disorders that might affect the myotome of the upper limbs[28, 29)]. However, there were substantial gender and age differences in HGS[8–10)]. The pinnacle of men's grip strength occurred in their twenties, after which it fell. The average grip strength of women peaked between the ages of 40 and 49 and thereafter declined[8–10)].

The current investigation discovered a statistically significant difference in HGS between the dominant hand when the head is in a neutral position and the non-dominant hand when the head is extended. This recommends that you should perform the most HGS with your dominant hand while your head is in a neutral position and avoid performing hand grips with your non-dominant hand when your head is extended, as these give the least grip strength.

In this study, NPNP was investigated to see how it affected HGS in medical professionals while they were in a variety of different head positions (neutral, flexion, and extension). However, one potential limitation of this study is that it does not assess HGS from a variety of postures with regard to a number of different head positions (such as rotation and side bending). In addition, no comparisons of HGS by gender, age, weight, body mass index, or severity of neck pain were made. In particular, these variables may have influenced the results. Finally, the sample size is another limitation to consider when generalising this study's findings. However, healthcare practitioners were the only study participants.

In conclusion, the results of this study showed that HGS is not significantly affected by head position in either healthy participants or those with NPNP. In addition, NPNP had no impact on HGS in various head positions for either the dominant hand or the non-dominant hand. Future research should include additional head-neck positions, such as rotation and side bending, while also taking into account potential characteristics that could affect hand grip strength (HGS), such as age, gender, weight, and pain intensity.

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Conflict of interest

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