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Original Article

ANALYSIS OF WRISTAND HAND TORQUE STRENGTH AMONG MALAYSIAN ADULTS FOR DESIGNING TORQUE WRENCH: A PILOT STUDY

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ABSTRACT

A pilot study was conducted to measure the wrist and hand torque strength of Malaysian adults for the purpose of designing a new torque wrench for conventional milling machine. In addition, the influence of physical factors such as hand anthropometry (forearm length, forearm circumference, palm-wrist length & palm circumference), height (cm), body weight (kg) and body Mass index (BMI) in wrist and hand torque strength were also quantified in the study. This study was conducted among 38 Malaysian adults from a public university in Malaysia. The measurements of wrist and hand torque strength were carried out for dominant hand in different standing height positions (shoulder height, waist height, elbow height, and eye height) for both clockwise and anti-clockwise directions. The wrist and hand torque strength was measured by using a handheld dynamometer, Mark 10 Series R52 M3i (USA) which was attached to a vertical test rig. Furthermore, hand anthropometry, height (cm) body weight (kg), height (cm) and BMI were also measured. The study results identified that the mean wrist and hand torque strength exerted by males was 25%-60% higher than females. In addition, a significant positive correlation (p< 0.05) was found between the wrist and hand torque strength and the hand anthropometry, height (cm) body weight (kg), height (cm) and BMI. The study findings might help the respective authorities to redesign a new torque wrench that applies ergonomics principles for milling machine users in the university. Moreover, this additional information on the wrist and hand torque strength might fill the gap in the strength data for the Malaysian population, or could be utilized by ergonomics practitioners in industries.

***KEYWORDS:** Wrist and Hand Torque, Malaysian Population, Hand Anthropometry, Milling Operation & Ergonomics*

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1. INTRODUCTION

The process of machining by using a rotator cutter to remove metal is known as milling [1]. The machine that was used during a milling process is known as the milling machine [1]. Currently, there are two models of conventional vertical milling machine (EnriqueHolke vertical milling machine and the Bridgeport vertical milling machine) available at the faculty of a public Malaysian university. During the vertical milling machine operation, the researcher had identified a few ergonomic issues that were faced by the machine users and one of them was during the handling of the drawbar. The drawbar is the vital part of the vertical milling machine, which provides a clamping mechanism to hold the tool holder or chuck. However, the drawbar was located at the top of the milling machine which causes the reaching of the drawbar to become very difficult since the machine's height was unadjustable. During manual handling of the drawbar, the torque wrench was an essential tool that will be used to tighten and unlock the drawbar (Figure 1.1). The users had to position the torque wrench in inclined orientation to reach the drawbar as the drawbar was located at top of the milling machine (Figure 1.2). This causes the torque wrench was not positioned at 90 degrees to the centre of rotation, which indirectly inhibits the maximum torque production. Furthermore, the short handle of the torque wrench does not provide a maximum torque and essential space between the users and the machine bed while reaching for the drawbar which indirectly causes the users to work in an awkward posture. The above scenario leads the users to apply an extra force during the operations of tightening and unlocking the drawbar. The increase in the force will eventually increase the risk of getting musculoskeletal disorders such as carpal tunnel syndromes, tendinitis, and etc. among the users [2, 3, and 4]. Hence, one of the practical ergonomic solutions for the above problem shall be to redesign a safe, comfort torque wrench that applies the ergonomics principles and meets the user's requirement. However, to redesign an ergonomic torque wrench, one of the factors that need to be considered is hand and wrist torque.

Figure 1.1: A Torque Wrench.

Figure 1.2: User Trying to Unlock the Drawbar by Using a Torque Wrench.

The hand and wrist torque exertions are often required in various work situations such as operating hand tools, manipulating knobs and valves [5]. The information on wrist and hand torque is very crucial in hand biomechanics as it can be applied for designing appropriate hand tools [6]. This will help to reduce musculoskeletal disorders and increase the productivity and performance of operation [7]. According to previous research studies, there are many factors that influence the wrist and hand torque such as gender, height, weight, bmi, and hand anthropometry [8, 9, 10, and 11]. Example a study conducted by kim & kum (2000), had proved that the mean torque value for men was higher compared to female [8]. In addition, a recent research study by yong-ku kong & dae-min kim (2015), had identified a significant relationship between the hand anthropometry and hand force [9]. However, as per the author concern, there was limited data available regarding the association between the abovementioned factors and wrist and hand torque among the Malaysian population. Therefore the findings from this pilot study can fill the gaps in strength data especially hand and wrist torque strength among the Malaysian population. In addition, these findings can also give important information for the respective authorities to design a safe and usable torque wrench for the users. Hence, the aim of the current pilot study was to measure the hand and wrist torque strength and to evaluate the association between the age, gender, height, weight, bmi and hand anthropometry on the hand and wrist torque strength at different heights in standing position among Malaysian population.

2. METHODOLOGY

2.1 Subjects

38 Malaysian young adults in one public university, between the ages of 18 to 25 were involved in the current pilot study. A convenience sampling method was used to recruit the subjects for the present study. The subjects with no history of low back pain shoulder and arm pain, neurological disorders and physical injuries were included in the current study. The informed consent was taken from the subjects before participating in the current study.

2.2 The Measurement of Anthropometric Data

In the present study, the subject's anthropometric data such as height, weight, forearm length, forearm circumference, palm to wrist length and palm circumference was collected. The subjects' weight and height were measured without the shoe, and with minimal or light clothing. The dominant forearm length (Figure 2.1), dominant forearm circumference (Figure 2.2), dominant palm-to-wrist length (Figure 2.3) and dominant palm circumference (Figure 2.4) were measured by using the inch tape. The forearm and upper arm circumference should be measured at the distance of two fingers from the elbow crease. All dimensions were recorded in centimetre (cm).

Figure 2.1: Forearm Length Measurement.

Figure 2.2: Forearm Circumference Measurement.

Figure 2.3: Palm-Wrist Length Measurement.

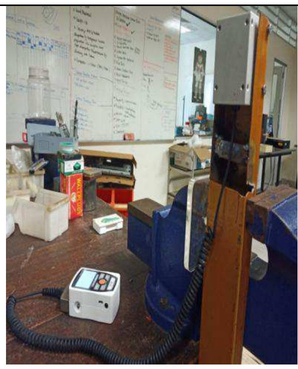
Figure 2.4: Palm Circumference Measurement.

2.3 Hand Wrist Torque Measurement Procedures

A hand-held dynamometer, Mark-10 Series R52 Model M3i (USA) was used to measure the maximum wrist and hand torque strength (Figure 2.5). The handheld dynamometer was either in the clockwise or anti - clockwise rotation. The device is capable to measure torque range from 7 Ncm to 1150 Ncm with an accuracy of ±0. 35%.

Figure 2.5: Mark-10 Series R52 Model M3i (USA).

The measurement unit is in Newton centimetre (N cm) and the display modes of the torque gauge were Real-Time (RT), clockwise and anti-clockwise directions. The force gauge was calibrated and certified according to the National Institute of Standards and Technology (NIST), United States of America (USA). Since the data collection should replicate the vertical milling machine in the machine shop, the torque strength data was obtained by clamping the torque gauge on a fabricated vertical test rig (Figure 2.6). The dynamometer was connected to the advanced 31 torque indicator which was mounted onto the vertical test rig as shown in Figure 2.7.

	
Figure 2.6: Vertical Test Rig	**Figure 2.7: Setting up of Torque Gauge on the Test Rig**

2.4 Familiarization of Data Collection Procedures

The subjects were given a familiarization regarding the procedures and methods before the real data collection. A demonstration was conducted by the researcher regarding the correct techniques and body postures to hold and twist the handle of the Mark-10 torque gauge. All subjects were given a fair chance to do a light trial of the test procedures for familiarization purposes. After performing the test, the subjects were provided with a rest period for at least two minutes before proceeding to the next test. The two minutes rest time was given to the subjects to wash out the effect of muscle fatigue due to the former test.

2.5 Wrist torque measurement procedure

Firstly, the subjects were required to stand facing the test rig. Next, the subjects were required to hold the handle of the socket wrench in a neutral position by using his/her dominant hand. The socket wrench was positioned at waist height (Figure 2.8). The participants were free to adjust the distance between his/her body with the toque gauge. Then, the subjects were instructed to gradually apply force and twist the handle of a torque wrench in a clockwise direction until they reached their maximum exertion and they were requested to hold for a few seconds (4 – 5 seconds). Finally, the subjects were requested to rest for two minutes and continue with the same procedures for clockwise and anticlockwise direction for waist height, elbow height, and shoulder height. The torque gauge was reset to “0” before the beginning of the new measurement. The readings were measured in Ncm and recorded in Microsoft Excel.

2.6 Hand Torque Measurement Procedure

Firstly, the subjects were required to stand facing the test rig. Next, the subjects were requested to hold the handle of the wrench within the shoulder height by using his/her dominant hand in a pronation position (Figure 2.9). The subjects are free to adjust the distance between his/her body with the toque gauge. Note that the hand position of the subjects should be perpendicular to the handle of the wrench. Next, the subjects were instructed to apply force gradually to the handle of the wrench in a clockwise direction until the maximum force exertion was reached and hold for a few seconds (4 – 5 seconds). Finally, the subjects were requested to exert the force purely from the arm region and not from the back region. The subjects were requested to rest for two minutes and the same procedures were repeated for anticlockwise direction for shoulder height, eye height, and overhead height. The torque gauge was reset to “0” before the beginning of the new measurement.

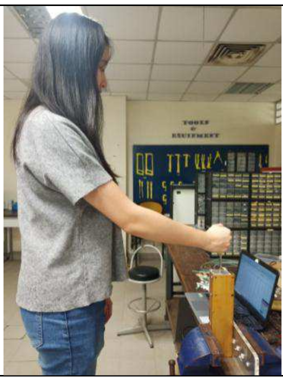


Figure 2.8: Participant Stands Facing Test the Rig for Wrist Torque Measurement at Waist Height.

Figure 2.9: Participant Stands Facing the Test Rig for Hand Torque Measurement at Shoulder Height.

3. DATA ANALYSIS

Statistical analysis associated descriptive statistics was performed by using SPSS software version 21. The demographic details and wrist and hand strength torque characteristics of the subject's population were tabulated (as mean, standard deviation, range, and percentiles). The Spearman's rank correlation coefficient analysis was performed to correlate the variables in the wrist and hand torque study such as gender, height, weight, BMI, and hand anthropometries (forearm length, forearm circumference, palm-wrist length, and palm circumference). The Spearman correlations will always be in between -1 and +1. Table 1 shows the guide for the absolute value of Spearman's correlation coefficient.

Table 1: Guide for Spearman's Correlation Coefficient

Range	Correlation
0.00 – 0.19	Very weak
0.20 – 0.39	Weak
0.40 – 0.59	Moderate
0.60 – 0.79	Strong
0.80 – 1.00	Very strong

4. RESULTS

Based on analysis, the majority of the subjects in the current study were male. Next, the mean height (m) and weight (kg) of the subjects were 1.66 m and 65.02 kg irrespectively. Table 2 tabulates the mean BMI for the subjects was 23.02. In addition, the mean hand anthropometries such as dominance forearm length [FL] (cm), dominance forearm circumference [FC] (cm), palm wrist length [PL] (cm) and palm wrist circumference [PC] (cm) were 0.25 (m), 0.23 (m), 0.17 (m) and 0.19 (m) irrespectively (Table 2).

Table 2: The Demographic Details

Variable	Mean	Median	S.D	Minimum	Maximum
Height (m)	1.66	1.69	0.10	1.47	1.88
Weight (kg)	65.02	65.0	16.15	40.00	93.00
BMI	23.06	22.2	3.69	17.778	29.6
Dominance Forearm Length (m)	0.25	0.25	0.03	0.22	0.38
Dominance Forearm Circumference (m)	0.23	0.24	0.04	0.15	0.30
Palm Wrist Length (m)	0.17	0.18	0.02	0.12	0.26
Palm Wrist Circumference (m)	0.19	0.19	0.02	0.16	0.26

Table 3 and Table 4 present the findings on the mean wrist and hand torque for the female subjects. The mean wrist torque (Ncm) was higher in the shoulder height for both torque direction. The mean wrist torque for shoulder height in the clockwise direction was 177.1 Ncm and 185 Ncm for an anti-clockwise direction. Next, for hand torque the highest hand torque for clockwise direction was produced at shoulder height, 663.6 Ncm and for anti-clockwise direction, the highest hand torque 610.8 Ncm was found at eye height.

Table 3: The Mean Wrist Torque in Female Subjects (Ncm)

Direction	Height		
	Waist Height	Elbow Height	Shoulder Height
Clockwise	148.7 (WTCW)	162.4 (WTCE)	177.1 (WTCS)
Anticlockwise	167.4 (WTACW)	184.8 (WTACE)	185.0 (WTACS)

WTCW = Wrist Torque at Waist Height (Clockwise)
WTACW =Wrist Torque at Waist Height (Anti Clockwise)
WTCE = Wrist Torque at Elbow Height (Clockwise)
WTACE = Wrist Torque at Elbow Height (Anti Clockwise)
WTCS = Wrist Torque at Shoulder Height (Clockwise)
WTACS = Wrist Torque at Shoulder Height (Anti Clockwise)

Table 4: The Mean Hand Torque for Female Subjects (Ncm)

Direction	Height		
	Shoulder Height	Eye Height	Overhead Height
Clockwise	663.6 (HTCS)	649.4 (HTCE)	609.5 (HTCO)
Anticlockwise	593.8 (HTACS)	610.8 (HTACE)	532.4 (HTACO)

HTCS = Hand Torque at Shoulder Height (Clockwise)
HTACS = Hand Torque at Shoulder Height (Anti clockwise)
HTCE = Hand Torque at Eye Height (Clockwise)
HTACE = Hand Torque at Eye Height (Anti Clockwise)
HTCO = Hand Torque at Overhead Height (Clockwise)
HTACO = Hand Torque at Overhead Height (Anti Clockwise)

Next, Table 5 and Table 6 present the findings on the mean wrist and hand torque for the male subjects. The mean wrist torque (Ncm) was higher in the shoulder height for both torque direction. The mean wrist torque for shoulder height in the clockwise direction was 389.8 Ncm and 442.0 Ncm for an anti-clockwise direction. Next for hand torque, the highest hand torque for both torque direction clock was produced at shoulder height; 1022.7 (Ncm) for clockwise direction and 814. 6 (Ncm) for anti-clockwise direction.

Table 5: The Mean Wrist Torque for Male Subjects (Ncm)

Direction	Height		
	Wrist Height	Eye Height	Shoulder Height
Clockwise	313.3 (WTCW)	359.7 (WTCE)	389.8 (WTCS)
Anticlockwise	298.2 (WTACW)	344.8 (WTACE)	442.0 (WTACS)

WTCW = Wrist Torque at Waist Height (Clockwise)
WTACW = Wrist Torque at Waist Height (Anti Clockwise)
WTCE = Wrist Torque at Elbow Height (Clockwise)
WTACE = Wrist Torque at Elbow Height (Anti Clockwise)
WTCS = Wrist Torque at Shoulder Height (Clockwise)
WTACS = Wrist Torque at Shoulder Height (Anti Clockwise)

Table 6: The Mean Hand Torque for Male Subjects (Ncm)

Direction	Height		
	Shoulder Height	Eye Height	Overhead Height
Clockwise	1022.7 (HTCS)	934.2 (HTCE)	855.3 (HTCO)
Anticlockwise	814.6 (HTACS)	805.8 (HTACE)	730.3 (HTACO)

HTCS = Hand Torque at Shoulder Height (Clockwise)
HTACS = Hand Torque at Shoulder Height (Anti clockwise)
HTCE = Hand Torque at Eye Height (Clockwise)
HTACE = Hand Torque at Eye Height (Anti Clockwise)
HTCO = Hand Torque at Overhead Height (Clockwise)
HTACO = Hand Torque at Overhead Height (Anti Clockwise)

Both Figure 4.1 and Figure 4.2 present the comparison of wrist torque (Ncm) and hand torque (Ncm) between male and female subjects. Male subjects were having highest wrist torque and hand torque (Ncm) compare to female subjects.

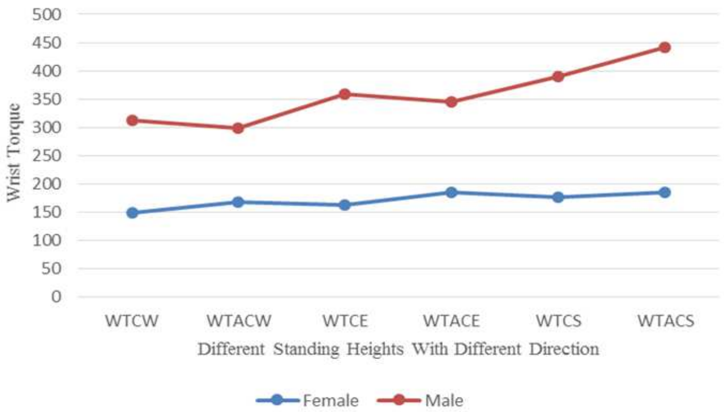


Figure 4.1: Comparison of Mean Wrist Torque (Ncm) Between Female and Male.

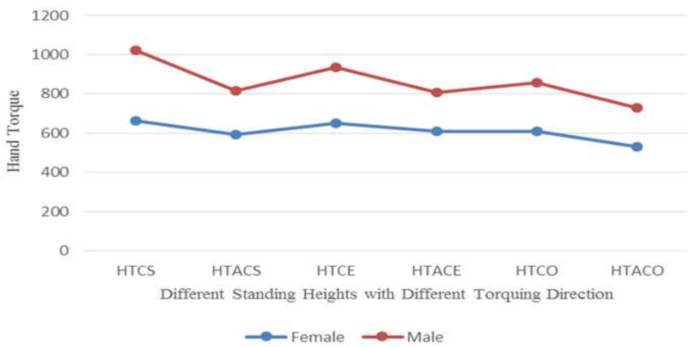


Figure 4.2: Comparison of Hand Torque (Ncm) Between Female and Male.

The correlation analysis between the wrist torque strength (Ncm) and factors was shown in Table 7. The factors such as gender, body height (m) and body weight (kg) were positively associated ($p< 0.05$) with the wrist torque strength (Ncm). The BMI was significantly associated [$p < 0.05$, $r_s = 0.32$] with the wrist torque strength. Furthermore, none of the hand anthropometries were associated with the wrist torque strength (Ncm) except for palm circumference. However, the palm circumference had a weak correlation with the wrist torque strength in different standing positions and torque direction. The correlation analysis between the hand torque strength (Ncm) and factors was presented in Table 8. Mostly all the variables were having moderate to good correlation between the hand torques and associated factors.

Table 7: The Correlation between Wrist Torque and Factors at Different Heights

Torqueing Height	Factors							
	Gender	Body Height (cm)	Weight(Kg)	B.M.I	FL (m)	FC(m)	PL(m)	PC(m)
Waist (CW)	r_s = 0.48* $p < 0.05$	r_s = 0.54* $p < 0.05$	r_s = 0.36* $p < 0.05$	r_s = 0.20 $p > 0.05$	r_s = 0.23 $p > 0.05$	r_s = 0.20 $p > 0.05$	r_s = 0.21 $p > 0.05$	r_s = 0.32* $p < 0.05$
Waist (ACW)	r_s =0.48* $p < 0.05$	r_s =0.51* $p < 0.05$	r_s = 0.30 $p > 0.05$	r_s = 0.12 $p > 0.05$	r_s = 0.13 $p > 0.05$	r_s = 0.23 $p > 0.05$	r_s = 0.24 $p > 0.05$	r_s =0.31* $p <0.05$
Elbow (CW)	r_s =0.51* $p < 0.05$	r_s =0.52* $p < 0.05$	r_s = 0.39* $p < 0.05$	r_s = 0.26 $p > 0.05$	r_s = 0.24 $p > 0.05$	r_s = 0.23 $p > 0.05$	r_s = 0.08 $p > 0.05$	r_s =0.34* $p < 0.03$
Elbow (ACW)	r_s =0.49* $p < 0.05$	r_s =0.50* $p < 0.05$	r_s = 0.37* $p < 0.05$	r_s = 0.25 $p > 0.05$	r_s = 0.27 $p > 0.05$	r_s = 0.23 $p > 0.05$	r_s = 0.05 $p > 0.05$	r_s =0.34* $p< 0.05$
Shoulder (CW)	r_s =0.61* $p < 0.05$	r_s =0.59* $p < 0.05$	r_s = 0.46* $p < 0.05$	r_s = 0.32* $p < 0.05$	r_s = 0.28 $p > 0.05$	r_s = 0.29 $p > 0.05$	r_s = 0.06 $p > 0.05$	r_s =0.43* $p <0.05$
Shoulder (ACW)	r_s =0.61* $p < 0.05$	r_s =0.57* $p < 0.05$	r_s = 0.41* $p < 0.05$	r_s = 0.26 $p > 0.05$	r_s = 0.28 $p > 0.05$	r_s = 0.23 $p > 0.05$	r_s = 0.04 $p > 0.05$	r_s =0.40* $p < 0.05$

p< 0.05 , * = significant correlation

Table 8: The Correlation between Hand Torque and Factors at Different Heights

Torqueing Height	Factors							
	Gender	Body Height (cm)	Weight(Kg)	B.M.I	FL (m)	FC(m)	PL(m)	PC(m)
Shoulder (CW)	r_s =0.66* $p < 0.05$	r_s =0.65* $p < 0.05$	r_s = 0.59* $p < 0.05$	r_s =0.41* $p < 0.05$	r_s =0.33* $p < 0.05$	r_s =0.58* $p < 0.05$	r_s =0.58* $p < 0.05$	r_s = 0.72* $p < 0.05$
Shoulder (ACW)	r_s =0.57* $p < 0.05$	r_s =0.49* $p < 0.05$	r_s = 0.44* $p < 0.05$	r_s =0.29* $p < 0.05$	r_s = 0.30 $p > 0.05$	r_s = 0.29 $p >0.05$	r_s =0.62* $p < 0.05$	r_s = 0.52* $p < 0.05$
Eye (CW)	r_s =0.54* $p < 0.05$	r_s =0.54* $p < 0.05$	r_s = 0.63* $p < 0.05$	r_s =0.58* $p < 0.05$	r_s =0.45* $p < 0.05$	r_s =0.64* $p < 0.05$	r_s =0.65* $p < 0.05$	r_s = 0.68* $p < 0.05$
Eye (ACW)	r_s =0.45* $p < 0.05$	r_s =0.59* $p < 0.05$	r_s = 0.54* $p < 0.05$	r_s =0.45* $p < 0.05$	r_s =0.48* $p < 0.05$	r_s =0.48* $p < 0.05$	r_s =0.48* $p < 0.05$	r_s = 0.62* $p < 0.05$
Overhead (CW)	r_s =0.45* $p < 0.05$	r_s =0.55* $p < 0.05$	r_s = 0.55* $p < 0.05$	r_s =0.42* $p < 0.05$	r_s = 0.27 $p >0.05$	r_s =0.54* $p < 0.05$	r_s =0.64* $p < 0.05$	r_s = 0.57* $p < 0.05$
Overhead (ACW)	r_s =0.62* $p < 0.05$	r_s =0.62* $p < 0.05$	r_s = 0.55* $p < 0.05$	r_s =0.40* $p < 0.05$	r_s =0.50* $p < 0.05$	r_s =0.49* $p < 0.05$	r_s =0.43* $p < 0.05$	r_s = 0.65* $p < 0.05$

p< 0.05 , * = significant correlation

5. DISCUSSIONS

A pilot study was conducted to identify wrist and hand torque strength and to identify the factors that influence the wrist and hand torque strength in different standing positions among Malaysian population in a public university. The findings will help to provide a piece of crucial information into the wrist and hand torque strength capabilities of the Malaysian population and can help to fill in the gap in the wrist and hand torque strength in Malaysia. Furthermore, the ergonomics designers in the university could apply the data to design an ergonomic and usable torque wrench to the users.

One of the main findings from the pilot study was that mean of wrist and hand torque strength exertion by males was higher compared to the force exerted by the female. The mean wrist and hand torque strength of a male was 25% - 60% higher compared to the female, which is consistent with the findings of previous research studies. A recent study [10] had identified that the mean wrist torque strength was 75% of male's wrist torque strength. The smaller physiological cross-sectional areas in terms of muscle mass and muscle recruitment might be the reason for the less force generation by females than males [12]. This study identified that mean wrist and hand torque strength for both male and female were higher in shoulder height. During the data collection in shoulder height position, it was observed that the shoulder was directed at 90 degrees from the body, with a combination of shoulder flexion, elbow extension, and wrist extension. According to an exploratory study conducted by the Xu [13], the maximum torque strength was generated when the joint was positioned as per above - mentioned position due to the joint torque combination from the shoulder flexion, elbow extension and wrist extension.

As presented in the current study, the mean value of wrist and hand torque has positively correlated with gender, height, body weight, BMI, and hand anthropometry. The gender was having moderate to strong correlation ($p<0.05$) with the wrist and hand torque strength in a different standing position. As explained in the above paragraph, the differences in the neuromuscular function and genetic composition in terms of muscle recruitment and muscle stimulation might cause the differences in the torque production between males and females [12]. The height was also correlated with the wrist torque strength among the subjects. The above findings were supported by another research [14] among the healthy subjects whereby the height was positively associated with the wrist torque strength among the younger healthy subjects. It has been noted that body heights were closely related to the muscle volume and lower lever arm which will indirectly help in generating high wrist and hand torque strength [15]. Next, the spearmen rank coefficient revealed a moderate correlation between body weight, and wrist and hand torque strength in the present study. This is in agreement with previously published studies, whereby a high BMI produces a greater torque force in the wrist and hand region [10, 16]. Theoretically, BMI was calculated as weight in (kg) divided with height in $(m)^2$ [17]. Therefore, individual height and weight were somehow could be related to the changes in the BMI. In the current findings, the researchers had found that factors such as BMI, height and weight were correlated with the wrist and hand torque among the subjects. Hence, we can assume that the three variables (height, weight and BMI) might have influenced each other in the wrist and hand torque strength readings in the current study.

With regard to the hand anthropometries, forearm length, forearm circumferences, palm-wrist length, and palm circumferences were correlated with the torque production in the wrist and hand region. Mostly all the hand anthropometries which includes forearm length, forearm circumferences, palm-wrist length, and palm circumferences were correlated with the hand torque production in different height position. However, for wrist torque strength, the hand anthropometries (palm circumference) were correlated only for the shoulder height position. A study conducted by Imrhan [18] had identified that hand anthropometry was significantly correlated ($p<0.001$) with the hand strength torque. In addition, another research work [19] had found a significant (O.R: 2.8; $p < 0.08$). Previous researcher had proposed that an increase in the hand length will increase in the hand surface which will indirectly increase the hand torque strength [20]. These might be a plausible explanation for the influence of hand anthropometry in the wrist and hand torque results in the current study.

To the author's knowledge, this is one of the new attempts to identify the correlation between gender, weight, height, BMI and hand anthropometry and wrist and hand torque strength. However, care should be taken when applying the current findings as the subjects in the current study might not be presenting the entire Malaysian population. Therefore, future studies should consider a bigger sample size population. However, as there was limited data available on wrist and hand torque strength, the university's respective authority may use the available information to design an ergonomic safe torque wench by considering the above discussed factors.

6. CONCLUSIONS

The results of the current study provide an insight into the wrist hand torque strength among the population a one public university in Malaysia. The mean wrist and hand torque strength exertion by the male was 25% - 60% higher than female. There was also a significant positive association between the wrist and hand torque strength and the above-mentioned factors such as height (cm), body weight (kg), BMI and hand anthropometry. This additional information on the wrist and hand torque strength of the university population can fill the gap in the strength data for Malaysians, or used by university's ergonomist to design a usable and safe torque wrench for the users.

7. ACKNOWLEDGEMENT

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