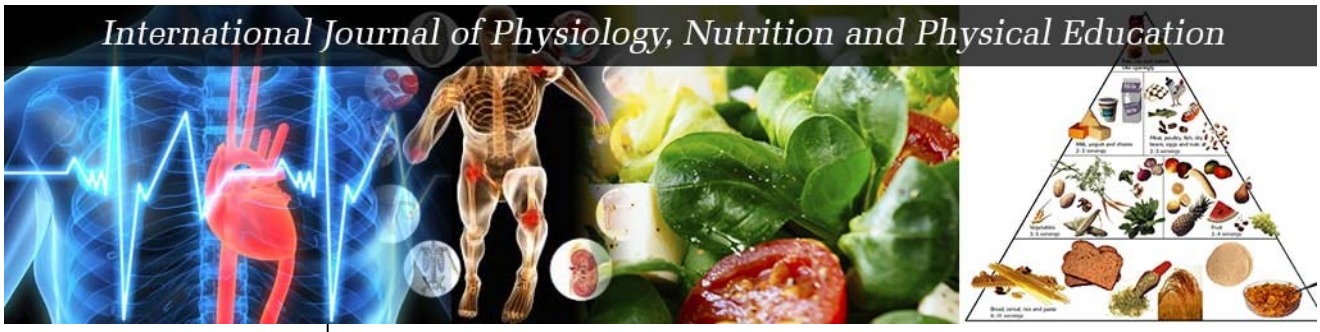

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Correlation of BMI and hand anthropometry with hand grip plus endurance for 1/3rd of Tmax among staff of teaching institute at Bengaluru, India

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Abstract
Background: The dimensional & anatomical features of the human hand & the factors such as the size, shape, texture of objects being held etc., influence the functional aspects of hand. Hand grip strength can be quantified while performing isometric exercises on hand grip dynamometer. Many studies have been conducted among athletes, players involved in grip sports and subjects working or employed in different types of industries like garments, beedi, agarbatti, vehicle parts assembly industries and have found significant correlation between hand anthropometry & hand grip plus endurance. But data are very scant among staff working in teaching institute.
Objective: To assess the correlation of BMI and hand anthropometry with hand grip plus endurance among staff of teaching institute.
Material and Methods: 61 female subjects were selected for the study based on inclusion & exclusion criteria. Among them 35 were working as typist cum clerk and 36 were working as teaching staff. The shape of the dominant hand was drawn on a piece of paper with a thin marker so that finger spans, finger lengths, and perimeters of the hand could be measured. Handgrip strength was measured in the dominant hand using hand grip dynamometer. Descriptive statistics were used for each variable and independent t test was used to analyze the differences between the two groups. The Pearson correlation coefficient test was used to evaluate the correlation between studied variables.
Result: Many hand anthropometric parameters and BMI of both teaching and clerk/typist groups significantly correlated ($p<0.05$ for both), with handgrip strength and endurance but handgrip strength and endurance of teaching staff and clerk/typist were similar.
Conclusion: Further researches related to the present topic are recommended as these can be used in talent identification in handgrip-related sports, design hand controlled products like remote control, mouse, key board and may be useful for ergo-design applications and in clinical settings as well.

Keywords: Hand anthropometry, handgrip, endurance.

Introduction
The human hand is a complex structure that performs various functions for activities of daily living and occupation [1]. The dimensional & anatomical features of the human hand & the factors such as the size, shape, texture of objects being held etc., influence the functional aspects of hand uses [2, 3]. Hand grip strength can be quantified by measuring the amount of static force that the hand can squeeze around a dynamometer and can be measured by subjecting patient to perform isometric exercise and endurance time can be measured by recording the time of onset of fatigue while performing isometric exercises on hand grip dynamometer. Measurements of forearm & hand dimensions are better predictor of grip strength than height & weight [4-6]. Further studies have shown that hand grip strength significantly correlated with hand dimensions like height: perpendicular to wrist crease, hand breadth & hand spread across edge [7].
Many studies have been conducted among athletes, players involved in grip sports and subjects working or employed in different types of industries like garments, beedi, agarbatti, vehicle parts assembly industries and have found significance of correlation between hand anthropometry & hand grip plus endurance. But data are very scant among staff working in teaching institutes. People involved in continuous writing / typing – computers are found to be working as clerk / typist or teaching staff in teaching institutes.

Constant writing considerably fatigues the hand and whole arm on account of the almost continuous and tense tension of muscles & tendons. Writer's cramp can appear when a person is trying to do a task that requires fine motor movements such as writing or playing a musical instrument and further the writer's cramp can affect an individual by interfering with their ability to write especially for prolonged periods of time. Hand anthropometry data can be used to design hand controlled products like remote control, mouse, key board and may be useful for ergo-design applications [7-10].

Hence, the aim of the present study has been to assess the correlation of BMI and hand anthropometry with hand grip plus endurance among staff of teaching institute.

Materials and methods: The study was carried out in the department of physiology, Dr. B.R. Ambedkar medical college, Bengaluru from March 2016 to September 2016. 61 female subjects were selected for the study based on inclusion & exclusion criteria. Among them 35 were working as typist cum clerk and 36 were working as teaching staff.

Inclusion criteria

1. Female staff aged between 25-38 years
2. Working in the teaching institute for more than 5 years.
3. Not taking any medication
4. No past history of any chronic illness

Exclusion criteria

1. Type 2 DM patients
2. Hypertensives
3. Hypothyroidism & hyperthyroidism
4. Hand deformities – congenital & accidents

Study protocol: Selected subjects were explained about the study and consent was obtained. Ethical clearance was taken by institute ethics committee. Subjects were tested for hand dominance, by asking questions about which hand was used to comb hair, throw a ball, or to write. Method of measurement of anthropometrical variables of hand was followed as per the original method reported by visnapuu and jurimae. The subjects were explained about the procedure and they were asked to be seated comfortably and instructed to spread and stretch out their dominant hand and place on a piece of paper located on the table. The outlines of the dominant hand were drawn by one examiner for all subjects. The contour of the hand was drawn with maximal active voluntary adduction of thumb and other fingers. Then three group of hand anthropometric variables were measured: 5 finger spans, 5 finger lengths and 5 perimeters of hand. Other variables like hand length, palm length, combined forearm plus hand length, hand width, hand circumference and forearm circumference were measured [11-13].

Measurement of BMI, hand grip strength and hand grip endurance

Hand grip strength was determined using hand grip dynamometer (Inco, Ambala India) as the maximal voluntary contraction sustained for at least 3 seconds. Hand grip endurance was determined by asking the subjects to maintain 1/3rd of maximal voluntary contraction (Tmax) for as long as she could. The hand grip dynamometer was calibrated at 12 and 18 kg before and after the study. It was accurate to less than ± 1% at 12 kg and accurate to less than ± 3 at 18 kg. Body height (to nearest 0.1cm) and body mass (to nearest 0.05 kg, were measured and body mass index (BMI) was calculated as the body mass per (height)2 in kg/m2 as the general anthropometric variables [6, 12, 13].

All the data recorded were entered into master chart.

Statistical analysis: The data were statistically analyzed by using smith's statistical software version 2.8 and descriptive statistics (mean & SD) were calculated for each variable. Independent test was used to compare the mean of variables Pearson correlation coefficient test was used to evaluate the correlation between variables.

Results were considered to be significant if their associated p-values were less than 0.05.

Results

Table 1: Basic characteristics, handgrip strength and endurance of subjects and p value of the t test

Variables	clerk/typist (n=35)	teaching staff (n=36)	P value
Age	30.39 ± 6.69	31.82± (6.22)	0.045
Body Height (cm)	156± (5.12)	154.04± (4.20)	0.021
weight (kg)	61.34± (9.21)	57.23± (7.13)	0.014
BMI (kg x m^{-1})	23.02± (1.68)	23.18± (2.47)	0.021
Hand grip (kg)	15.15(6.98)	17.70(4.68)	0.013
Endurance	14.46(5.62)	16.32(5.6)	0.011

BMI; body mass index.

Table 2: Anthropometric parameters of hand and p value of t test between groups

Hand Variable	clerk/typist	Teaching staff	*P* value
FS1	10.46±1.54	10.25±1.25	0.173
FS2	13.56±1.64	13.56±1.22	0.077
FS3	15.78±1.67	15.98±1.56	0.073
FS4	17.62±2.36	17.66±1.45	0.091
FS5	24.68±2.68	24.65±2.62	0.081
TL	11.33±0.67	11.86±1.23	0.004
IFL	16.38±1.43	16.82±1.89	0.010
MFL	17.01±1.35	17.83±0.65	0.010
RFL	16.15±1.32	16.62±0.55	0.013
LFL	12.51±1.23	12.87±0.55	0.006
P1	42.28±2.33	43.36±2.12	0.005
P2	48.69±3.52	49.23±3.97	0.012
P3	41.36±2.91	41.87±2.66	0.004
P4	43.56±3.36	44.15±2.33	0.001
P5	55.56±2.78	56.61±3.99	0.011
Hand length	16.14±1.57	17.87±0.86	0.001
Palm length	8.20±1.04	8.898±0.59	0.013
Palm width	7.32±0.44	7.99±0.34	0.013
Forearm length	20.43±1.66	21.22±2.11	0.014
Forearm C	16.94±1.49	17.66±1.57	0.001
Wrist C	12.02±0.41	12.28±0.23	0.011

Finger Spans (FS1, FS2, FS3, FS4 and FS5), Finger Lengths (TL-thumb length, IFL Index Finger length, MFL-Middle finger length, RFL- Ring finger length, LFL-Little finger length), and 5 Perimeters (P1, P2, P3, P4, P5), Forearm C; forearm circumference, Wrist C: Wrist circumference

Table 3: Relationship between handgrip strength, endurance and BMI of subjects

Hand Variable	Clerk/typist (n=35)	Teaching staff (n=36)
Hand grip (kg)	0.672(0.01)*	0.689(0.001)*
Endurance	0.451(0.02)*	0.658(0.01)*

* r value

Table 4: Relationship between hand - specific anthropometric parameters and handgrip strength.

Variable	Clerk/typist (n=35)	Teaching staff (n=36)
FS1	0.164(0.252)*	0.175(0.263)*
FS2	0.212(0.242)*	0.222(0.212)*
FS3	0.217(0.178)*	0.257(0.168)*
FS4	0.236(0.098)*	0.276(0.088)*
FS5	0.210(0.172)*	0.225(0.182)*
TL	0.355(0.025)*	0.395(0.014)*
IFL	0.363(0.018)*	0.395(0.016)*
MFL	0.332(0.36)*	0.367(0.23)*
RFL	0.288(0.93)*	0.297(0.83)*
LFL	0.345(0.045)*	0.376(0.012)*
P1	0.354(0.050)*	0.313(0.020)*
P2	0.309(0.068)*	0.315(0.048)*
P3	0.313(0.050)*	0.354(0.037)*
P4	0.341(0.032)*	0.333(0.042)*
P5	0.324(0.050)*	0.3145(0.039)*
Hand length	0.243(0.125)*	0.453(0.015)*
Palm length	0.226(0.113)*	0.289(0.081)*
Palm width	0.460(0.003)*	0.489(0.002)*
Forearm length	0.041(0.690)*	0.065(0.555)*
Forearm C	0.522(0.001)*	0.577(0.001)*
Wrist C	0.363(0.013)*	0.460(0.002)*

Finger Spans (FS1, FS2, FS3, FS4 and FS5), Finger Lengths (TL-thumb length, IFL Index Finger length, MFL-Middle finger length, RFL- Ring finger length, LFL-Little finger length), and 5 Perimeters (P1, P2, P3, P4, P5), Forearm C; forearm circumference, Wrist C: Wrist circumference. * r value

Table 5: Relationship between hand - specific anthropometric parameters and endurance.

Varible	Clerk/typist (n=35)	Teaching staff (n=36)
FS1	0.154(0.265)*	0.185(0.203)*
FS2	0.213(0.242)*	0.225(0.232)*
FS3	0.223(0.168)*	0.277(0.136)*
FS4	0.239(0.087)*	0.267(0.078)*
FS5	0.245(0.152)*	0.265(0.141)*
TL	0.355(0.025)*	0.385(0.011)*
IFL	0.333(0.015)*	0.375(0.011)*
MFL	0.328(0.36)*	0.357(0.15)*
RFL	0.279(0.73)*	0.287(0.64)*
LFL	0.385(0.0255*)	0.496(0.002)*
P1	0.374(0.040)*	0.389(0.010)*
P2	0.329(0.068)*	0.365(0.038)*
P3	0.323(0.040)*	0.364(0.029)*
P4	0.341(0.032)*	0.383(0.034)*
P5	0.324(0.050)*	0.3145(0.039)*
Hand length	0.343(0.025)*	0.489(0.015)*
Palm length	0.326(0.0413)*	0.459(0.051)*
Palm width	0.450(0.013)*	0.497(0.002)*
Forearm length	0.041(0.590)*	0.075(0.585)*
Forearm C	0.543(0.001)*	0.587(0.001)*
Wrist C	0.367(0.013)*	0.413(0.012)*

Finger Spans (FS1, FS2, FS3, FS4 and FS5), Finger Lengths (TL-thumb length, IFL Index Finger length, MFL-Middle finger length, RFL- Ring finger length, LFL-Little finger length), and 5 Perimeters (P1, P2, P3, P4, P5), Forearm C; forearm circumference, Wrist C: Wrist circumference. * r value

Results

Results are depicted in table 1 to 5. Table 1 showed baseline characteristics and handgrip strength of subjects and P value of the t test. Table 2 showed mean and standard deviation of anthropometric parameters of hand and P value of t test between groups. Table 3 showed relationship between handgrip strength, endurance and BMI of subjects. Table 4 showed relationship between hand - specific anthropometric parameters and handgrip strength. Table 5 showed relationship between hand - specific anthropometric parameters and endurance. BMI significantly correlated (r value) with handgrip strength, endurance among both groups with (p<0.05). Among clerks/typists, the hand anthropometric parameters like IFL, LFL, P3, P4, P5, palm width, MF length, forearm circumference and wrist circumference showed positive correlation (p<0.05), with handgrip strength. Similarly among teaching staff the hand anthropometric parameters like hand variables like TL, IFL, LFL, P1, P2, P3, P4, P5, hand length, palm width, MF length, forearm circumference and wrist circumference showed positive correlation (p<0.05), with handgrip strength. Among clerks/typists, the hand anthropometric parameters like TL, IFL, LFL, P1, P3, P4, P5, palm length, palm width, MF length, forearm circumference and wrist circumference showed positive correlation (p<0.05), with endurance. Similarly among teaching staff, the hand anthropometric parameters like TL, IFL, LFL, P1, P2, P3, P4, P5, hand length, palm length, palm width, MF length, forearm circumference and wrist circumference showed positive correlation with endurance (p<0.05).

Discussion

The present study was conducted to determine the correlation of BMI and hand anthropometry with hand grip plus endurance for 1/3rd of Tmax among staff of teaching institute. By and large many hand anthropometric parameters and BMI of both teaching and clerk/typist groups significantly correlated with handgrip strength and endurance. Very few studies were found that address the present topic.

Among clerks/typists, the hand anthropometric parameters like IFL, LFL, P3, P4, P5, palm width, MF length, forearm circumference and wrist circumference showed positive correlation (p<0.05), with handgrip strength. Similarly among teaching staff the hand anthropometric parameters like hand variables like TL, IFL, LFL, P1, P2, P3, P4, P5, hand length, palm width, MF length, forearm circumference and wrist circumference showed positive correlation (p<0.05), with handgrip strength. However, the results showed that handgrip strength and endurance of teaching staff and clerk/typist were similar. Ali AF, Ali AJ conducted study among athletes and non athletes and found that some hand dimensions and anthropometric parameters like in 5 finger lengths (TL: p<0.001, IFL: p<0.001, MFL: p<0.00, RFL: p<0.001, LFL: p<0.001), and 5 perimeters (P1: p<0.001, P2: p<0.001, P3: p<0.001, P4: p<0.001, P5:p<0.013), there was a significant difference between the groups. In addition, hand length (p=0.002), palm width (p<0.001), F3 length (p<0.001), forearm length (p=0.013), forearm circumference (p<0.001) and wrist circumference (p<0.001) were significantly different between the groups attributing to good positive correlation between handgrip strengths and anthropometric characteristics of hand in grip athletes [14]. Hager-ross and Schieber, investigating children at different ages, confirmed that hand length (the distance from wrist joint to the tip of middle finger) is an important variable for handgrip strength (15). Studies of Nicolay and Walker showed that there was significant but low correlation between finger length and handgrip strength in college students [16]. Visnapuu and

Jurimae indicated that hand perimeters are the most important hand anthropometric variables in relation to handgrip strength [11]. Study conducted among Indian women showed that handgrip strengths of the Indian women were much less than those of the American, British and West Indian women. Grip strength was found to be significantly correlated with three hand dimensions- hand length, breadth, and hand spreads [7]. Ducharme involving 1400 women with US air force observed that soldering tools, pliers and wire strippers caused frequent complaints in women workers, due to dimensional incompatibility and improper usage of tools [17]. Okunribido measured 18 dimensions of hand in 37 females from Ibadan and western Nigeria and compared them with those of other populations. The results showed that hand dimensions differed between populations [18]. Among clerks/typists, the hand anthropometric parameters like TL, IFL, LFL, P1, P3, P4, P5, palm length, palm width, MF length, forearm circumference and wrist circumference showed positive correlation (p<0.05), with endurance. Similarly among teaching staff, the hand anthropometric parameters like TL, IFL, LFL, P1, P2, P3, P4, P5, hand length, palm length, palm width, MF length, forearm circumference and wrist circumference showed positive correlation (p<0.05), with endurance. Study conducted among brick field workers and their sedentary or control counterparts showed that the hand grip and endurance were higher among brick workers possibly due to greater percentage of muscularity, lesser fat content and greater hand anthropometric values among brick workers [19].

Another study conducted on151 males (103 right handed and 48 left handed) and 152 females (129 right handed and 23 left handed) collegiate population of Amritsar, Punjab, India, aged 18-25 years indicated that statistically significant differences (p<0.05) were found for hand grip strength both in males and females between right hand dominant and non-dominant groups (t=3.13 and 2.78 respectively) and left hand dominant and non-dominant groups (t=2.66 and 3.13 respectively) [20].

In another study based on the association of hand grip strength (both left and right) with height, weight and BMI on randomly selected 600 normal healthy individuals(300 boys and 300 girls) aged 6-25years of Amritsar, Punjab, indicated a strong association of right and left hand grip strength with height (r=0.925 and 0.927 respectively in boys and r=0.800 and 0.786 respectively in girls), weight (r=0.882 and 0.878 respectively in boys and r=0.698 and 0.690 respectively in girls) and with BMI (r=0.636 and 0.632 respectively in boys and r=0.477 and 0.472 respectively in girls) [21].

Conclusion

The present study has shown that many hand anthropometric parameters and BMI of both teaching and clerk/typist groups significantly correlated with handgrip strength and endurance but handgrip strength and endurance of teaching staff and clerk/typist were similar, indicating possibly the nature of work of teaching staff and clerk/typist are similar and have minimal effect over hand grip strength and endurance. When using hand anthropometry data, choosing the appropriate dimensions and number of populations and individuals for the purpose of the study is very important. Accurate anthropometry data of the hand will be useful to develop a hand kinetics model in future research studies [22].

Limitations of present study

1. Sample size could have been larger.
2. The number of hours/day of typing or writing by clerk/typist and teaching staff was not considered.
3. Subjects were included based on the duration of service and whether they were involved in any other type of hand work apart from their duty hours at the institute was not considered.

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Conflict of Interest: Nil

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