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Hand Grip Strength: An Assessment Criteria of Upper Extremity Musculoskeletal Disorders in Indian Collegiate Computer Users

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Abstract

The purpose of this study was two-fold: first, to evaluate the anthropometric profile of Indian computer students and, second, to search the correlation of hand grip strength with other anthropometric characteristics studied.

Methods: Fourteen anthropometric characteristics; viz. height, sitting height, weight, BMI, knee height, thigh height, leg length, bi-trochantric diameter, waist and hip circumferences, percent body fat, percent lean body mass, hand grip strength (right dominant) and back strength were measured on purposively selected 208 Indian computer students (108 males,100 females) ages 18–25 years (mean 21.67 years, ± 1.61) collected from Guru Nanak Dev University, Amritsar, Punjab, India. An adequate number of non-computer users (n = 208, 108 males,100 females, mean age 21.72 years, ± 1.69) were also collected as controls from the same location for comparison.

Results: One way ANOVA showed significant differences among the groups (p≤ .001 - .000) in the variables studied, except the hip circumference, in computer students and controls. In Indian computer students, significant positive correlations (p≤ .05 - .01) were found in hand grip strength and height, sitting height, leg length, back strength (in both sexes), knee height (females only), weight, BMI, bi-trochantric diameter, waist circumference, hip circumference, % body fat and % lean body mass (males only).

Conclusion: Despite the higher BMI status, Indian computer students had both lower handgrip strength and back strength than their control counterparts, possibly linked to their poor physical activity in work stations.

Key Words: Anthropometric variables, hand grip strength, Indian computer students.

Introduction

The use of the personal computers (PC) worldwide has increased tremendously due to the evolution of computer technology (1). In the United States, PCs per capita reached 80% in 2006 and are expected to reach 98% by 2012 (2).

Apart from different types of work settings, college and university students are using PC's extensively in their studies, consulting e-journals, e-books, e-mails, and net surfing through data-base search engines. Reports show that with the prolonged and extensive use of computers, young computer users suffer from various forms of musculoskeletal disorders (MSDs). Apart from the muscle pain and tendinitis (the most common diagnoses), carpal tunnel syndrome is also prevalent in VDT (video display terminal). Sometimes VDT is a term used, especially in ergonomic studies, for the computer display users (3). It is an important health outcome in respect to the lost work days with which it can be associated. Estimation of hand grip strength is an important tool for the assessment of carpal tunnel syndrome.

Handgrip is a measure of strength of several muscles in the hand and forearm. The power of grip is the result of forceful flexion of all finger joints with a maximal voluntary force that the subject is able to exert under normal biokinetic conditions (4, 5). Hand grip strength is a physiological variable that is affected by a number of factors including age, gender and body size among others. In fact, the grip strength was reported to be higher in the dominant hand with right handed subjects, but no such significant differences between sides could be documented for left handed persons (6). Right and left hand grip strength was positively correlated with weight, height, and body surface area (7). In case of relationships of hand grip strength with stature, weight, arm and calf circumferences, and various subcutaneous skin folds, it was found that males attained greater values for these anthropometric variables and had greater hand grip strength values than their female counterparts (8). It was found too that both age-dependent increases of hand grip strength in both sexes, as well as inter-gender differences, were strongly associated with changes of fat-free mass during their childhood (9). Hand grip strength is found to be a significant determinant of bone mineral content. Bone area at the forearm sites has a positive correlation with lean body mass and physical activity. This determines the muscular strength of an individual (10). Hip/waist circumferences measurement is a good marker of fat mass, bone mineral content, and lean mass, which are strongly correlated with maximum isometric grip force (11). The hand grip strength is positively associated with nutritional status, even after controlling for potential confounders including health status and socioeconomic conditions (12). The information regarding the association of hand grip strength as an indicator of upper extremity musculoskeletal disorders is scanty, especially in the Indian collegiate population, so the present study was planned.

Materials and Methods

Subjects

The present study is based on 208 randomly selected, unrelated, normal, healthy Indian computer students (108 males, 100 females) ages 18–25 years, of Guru Nanak Dev University, Amritsar, Punjab, India. An adequate number of non-computer users (n=208, 108 males, 100 females) were also collected as controls from the region. The age of the subjects were recorded from records from their institute. The subjects were divided so that age 18, for example, refers to the students aged 17 years 6 months through 18 years 5 months and 29 days. A written consent was obtained from all subjects. Data was collected under natural environmental conditions in the morning (between 8 a.m. to 12 noon). The study was approved by the local ethics committee.

Anthropometric measurements

Fourteen anthropometric characteristics, viz. height, sitting height, weight, BMI, knee height, thigh height, leg length, waist and hip circumference, percent body fat , percent lean body mass, hand grip strength (right dominant) and back strength were taken on each subject. All the anthropometric variables of the subjects were measured using the standard techniques (13) and were measured in triplicate with the median value used as criterion.

The height and sitting height were recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. BMI was then calculated using the formula weight (kg)/height^2 (m)^2. Waist and hip circumference was measured by a flexible metallic tape (Holtain Ltd). Knee height, thigh height, leg length, and bi-trochantric diameter were measured by the first segment of the anthropometer. Percent body fat was assessed after Womersley and Durnin (14). Percent lean body mass was calculated subtracting percent body fat from 100.

Hand grip strength measurement

The grip strength of dominant (right or left) hand was measured using a standard adjustable digital hand grip dynamometer (Takei Scientific Instruments Co., LTD, Japan) at standing position with shoulder adducted and neutrally rotated, with elbow in full extension. The subjects were asked to put maximum force on the dynamometer thrice from both sides of the hands. The maximum value was recorded in kilograms. Anthropometric equipment and handgrip dynamometer were calibrated before each assessment. Thirty seconds time intervals were maintained

between each handgrip strength testing.

Back strength measurement

The back strength was measured using back-leg-chest dynamometer. The subject was positioned with body erect and knees bent so that grasped-hand rests at proper height. Then straightening the knees and lifting the chain of the dynamometer, pulling force was applied on the handle by the subject. The body was inclined forward at an angle of 60 degrees. The strength of the back muscles was recorded on the dial of the dynamometer as the best of three trials measured in kg. All subjects were tested after three minutes of independent warm-up. Thirty second time intervals were maintained between each back strength testing. The instruments were calibrated prior to use and all measurements were taken on the subjects' right side.

Statistical analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived

Table 1: Descriptive statistics of various anthropometric characteristics in Indian computer students and controls
* Significant at .001 level; ** Significant at .000 level

Variables	Computer students (n=208)				Controls (n=208)			
	Males (n=108)		Females (n=100)		Males (n=108)		Females (n=100)	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Height (cm)**	172.03	±5.11	157.43	±5.35	172.75	±6.9	159.71	±5.53
Sitting height (cm)**	88.56	±3.25	82.64	±3.00	89.19	±4.78	83.53	±3.044
Weight (kg)**	69.87	±11.80	54.08	±7.85	65.44	±9.40	53.26	±5.23
BMI (kg/m^2)**	23.55	±3.57	21.85	±3.19	22.00	±3.0	20.98	±2.11
Knee height(cm)**	43.53	±3.67	42.37	±2.43	45.88	±3.96	43.31	±3.06
Thigh height (cm)**	53.06	±4.95	47.84	±4.19	52.45	±3.83	47.76	±3.40
Leg length (cm)**	97.55	±4.76	90.09	±4.53	98.22	±5.48	91.31	±4.93
Bitrochantric Diameter (cm) **	31.45	±1.74	29.25	±3.57	31.32	±7.64	29.50	±1.67
Waist circumference (cm)*	75.46	±16.15	72.74	±7.17	76.05	±7.45	70.97	±7.94
Hip circumference (cm)	90.68	±15.92	89.73	±7.80	90.21	±7.64	87.91	±5.13
Hand Grip Strength (right) (kg)**	40.82	±8.97	23.69	±3.71	40.90	±6.47	24.04	±3.72
% BF (%)**	19.04	±4.74	26.50	±4.42	16.88	±3.55	25.2	±2.78
%LBM (%)**	80.98	±4.77	73.50	±4.41	83.12	±3.55	74.11	±7.50
Back strength (kg)**	109.41	±23.14	49.60	±11.97	116.45	±19.12	63.08	±13.28

variables. One way ANOVA (analysis of variance) was tested for the age-related comparisons of data among Indian computer students and controls, followed by post hoc Bonferroni test (in the case of significant differences). Pearson's correlation coefficients were applied to establish the relationships among the variables measured. Data was analyzed using SPSS (Statistical Package for Social Science) version 14.0. A 5% level of probability was used to indicate statistical significance.

Results

Descriptive statistics of anthropometric variables in Indian computer students and controls are shown in Table 1. Both male and female computer students have higher mean values (12.80% and 5.16% respectively) for % body fat, but lesser mean values for hand grip strength (right dominant) (0.20% and 1.78% respectively) and for back strength (6.43% and 12.32% respectively) than their control counterparts. One way ANOVA showed significant between-group differences ($p \leq .001$ - .000) in all variables studied, except hip circumference, in computer students as well as controls.

Correlation co-efficients of hand grip strength (right dominant) with other anthropometric variables in Indian computer students and controls are shown in Table 2. In Indian computer students, significant positive correlations ($p \leq .05$ - .01) were found in hand grip strength and height, sitting height, leg length, back strength (in both sexes), knee height (females only), and weight, BMI, bitrochantric diameter, waist circumference, hip circumference, % body fat and %lean body mass (males only). Almost the same trend was noted for controls.

Table 2: Correlation coefficients of hand grip strength (right dominant) with other variables in Indian computer students and controls
** Correlation is significant at the 0.01 level; * Correlation is significant at the 0.05 level

Corr. With Hand Grip Strength(right)	Computer group(r)		Collegiate group(r)	
Variables	Boys(group=3)	Girls(group=4)	Boys(group=1)	Girls(group=2)
Height	0.284**	0.248*	0.212*	0.223*
Sitting height	0.220*	0.259**	0.172	0.272**
Weight	0.375**	0.194	0.464**	0.223*
BMI	0.291**	0.074	0.430**	0.061
Knee height	0.092	0.247**	0.156	0.029
Thigh height	0.180	0.191	0.183	0.268**
Leg length	0.239*	0.298**	0.263**	0.223*
Bitrochantric Diameter	0.341**	0.105	0.107	0.094
Waist circumference	0.305**	0.091	0.312**	0.142
Hip circumference	0.241*	0.050	0.250**	0.290**
% BF	0.281**	0.070	0. 423**	0.069
%LBM	0.278**	-0.073	-0.423**	-0.106
Back strength	0.542**	0.502**	0.673**	0.466**

Discussion

Grip strength has long been thought of as a possible predictor of overall body strength but scant scientific data exists. Smith et al (15) found a direct correlation in grip strength and overall body strength in the elderly female populations. It is also reported that hand grip strength determines the muscular strength of an individual (10). The present study indicated that both male and female computer students had higher mean values in body weight, BMI, % body fat and some circumferential measurements, but lower mean values in hand grip strength (right dominant), % lean body mass, and back strength than controls. It might be assumed that prolonged computer use in the sitting position could be linked to the habit of physical inactivity and less energy expenditure of the computer students. Intake of excess energy in the form of coffee and snacks during computer

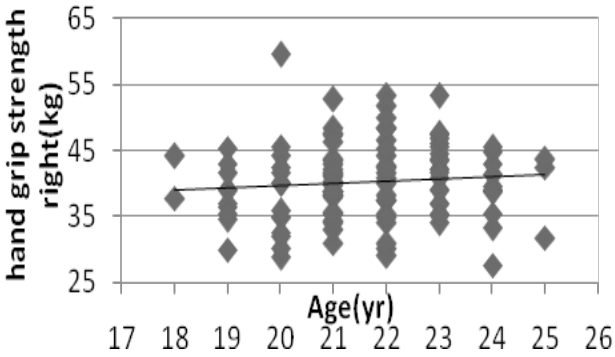

Figure 1: Scatter plot of hand grip strength of Indian computer male students

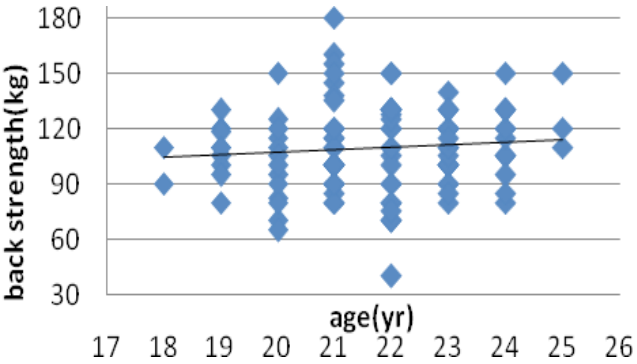

Figure 2: Scatter plot of back strength of Indian computer male students

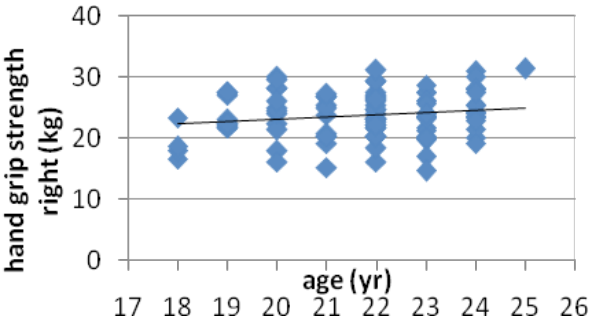

Fig.3: Scatter plot of hand grip strength of Indian computer female students

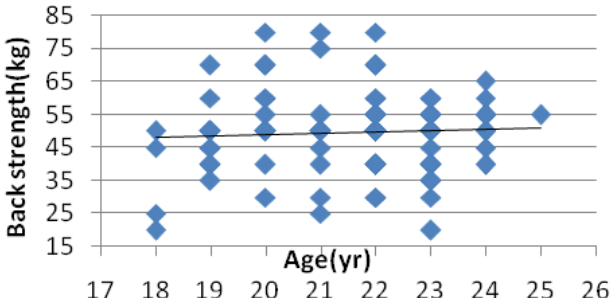

Fig. 4: Scatter plot of back strength of Indian computer female students

work makes them more prone to overweight (BMI higher than 25 kg/m^2). As a consequence, prolonged-computer-users are prone to repeated strain injury, carpal tunnel syndrome, trapezius and shoulder tightening, arm pain, neck shoulder pain, low back pain, and other complications (16-21). With the complications of carpal tunnel syndrome in computer users, severe cases might result in the loss of coordination and grip strength (22).

In fact, prolonged computer use is associated with CTS, etc, and it is a known cause of decreased grip strength. Furthermore, Chilima and Ismail (12) reported that hand grip strength was positively associated with nutritional status, even after controlling for potential confounders including health status and socioeconomic conditions. It was reported that poor nutritional status, defined by low BMI and low arm muscle area, emerged as a significant determinant of impaired handgrip strength (23). In our earlier study (24) it was reported that female manual laborers had lower mean values in all variables used as nutritional indicators and also had lower values of handgrip strength as compared to sedentary females, lending the support to the findings that handgrip strength is positively associated with nutritional status as reported in Japan (25), in central Malawi (26) and in Rwanda (23).

The findings of the present study contradicted the general notion that computer students not considered underweight due to BMI status still showed hand grip strength significantly lower than the controls. Reasons might be due to repetitive constrained work (excessive use of fingers during computer use) with inadequate physical activity. So, with the findings of the study, it may be concluded that occupation or work style may be an important determinants of hand grip strength, which further, is an indicator of possible upper extremity disorders.

Conclusion

Despite their higher BMI status, Indian computer students had both lower hand grip strength and back strength than their control counterparts, because of their poor physical activity at work stations. This was an observational study which revealed that poor physical activity status was associated with poor handgrip strength. Further studies of this type are required if we hope to improve the computer users' health status by providing regular exercise programs, and education about biomechanically healthy working habits.

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