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Estimation of Handgrip Strength in Patients with Type-2 Diabetes Mellitus

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Abstract: ***Introduction: Type-2 diabetes mellitus (T2DM) is the most common endocrine disorder worldwide. The objectives of the present study were to estimate the handgrip strength of Type-2 diabetic patients and to search its correlations with selected anthropometric variables studied. Materials and Methods: A total of 576 purposively selected Type-2 diabetic patients (251 male and 325 female) aged 35-60 years were considered as samples. An adequate number of controls (n=440; males 152, females 288) were also taken from the same place for comparisons. To serve these purposes, dominant and non-dominant handgrip strength and three anthropometric variables, viz. height, weight and body mass index were measured on all the subjects. Age of the subjects was estimated from their date of birth. Results: In results, one way analysis of variance showed significant between-group differences ($p \leq 0.001$) in all the variables studied between the patients with T2DM and controls. Significant sex differences ($p \leq 0.001$) were found in all the variables studied between the male and female patients. Both in male and female patients with T2DM, significant correlations ($p \leq 0.001$) of dominant and non-dominant handgrip strength were found with all the anthropometric variables studied. Conclusion: In conclusion, it may be stated that handgrip strength of patients with T2DM was reported to be significantly lower than there control counterparts.***

Keywords: Handgrip strength. Anthropometric variables. Patients with Type-2 diabetes mellitus

1. Introduction

1) Type-2 diabetes mellitus is a chronic metabolic condition characterized by high blood glucose due to defects of pancreatic beta cells and resistance of insulin of target tissues such as skeletal muscles, adipose tissues, and liver (Defronzo, 1992). According to International Diabetes Federation (2013), type-2 diabetes mellitus affects 382 million people worldwide and expected to rise to 592 million by 2035. Diabetes Atlas estimates the number of persons with diabetes in India to rise from 40 million in 2007 to 70 million in 2025 earning the dubious distinction of "diabetes capital of the world". The highest number of diabetic patients by 2025 will be in India, China, and United States (King et al., 1998; Ramachandran et al., 2007). According to WHO (1994), this problem has been aggravated by rapid cultural and social dynamics, ageing populations, increasing urbanization, dietary changes, reduced physical activity and other unhealthy lifestyle and behavioural patterns.
2) Type-2 diabetes mellitus patients are susceptible to higher disabilities in self-care tasks and daily routine activities as compared to non-diabetic subjects due to enormous hand complications (Badran et al., 2012). However, lesser attention has been paid to functioning of hand in type-2 diabetes patients as compared to diabetic foot and other diabetic complications (Redmond et al., 2009).
3) Development of physical disability in diabetic patients involves loss of muscle strength including grip strength. Lower handgrip strength being general indicator of muscle strength has been linked with premature mortality in middle-aged and elderly subjects (Metter et al., 2002). The longer the duration of diabetes greater will be reduction of handgrip strength and agility resulting in disabilities (Khallaf et al., 2014). The connective tissues of the hand are also damaged due to metabolic irregularities in type-2 diabetes mellitus, resulting in limitation in joint range of motion (Gamstedt et al., 1993).
4) Considering the above mentioned facts regarding the diabetic handgrip strength, the objectives of the present study were to estimate the the handgrip strength of patients with Type-2 diabetes mellitus form India, and to search its correlations with selected anthropometric variables studied.

2. Materials and Methods

1) Participants

The study was conducted in the Department of Physiotherapy, Guru Nanak Dev University, Amritsar, India, after taking Institutional ethical clearance and informed consent of the subjects in a time-span of one year. Study group consists of 576 confirmed cases of type-2 diabetic mellitus (251 male, 325 female) with a mean duration of diabetes of more than 5 years, and 440 controls (152 male, 288 female) without any history of glucose intolerance. The subjects ranged from age group 35 -65 years. A total of 559 (97.05%) samples of the present study were right hand dominant. The Age of the subjects was estimated from their date of birth. The subjects with any history of pain and musculoskeletal problems in the shoulder, arm or hand, documented history of trauma or brachial plexus injury, or cervical radiculopathy in the previous 6 months of the commencement of the study were excluded from the study. A written consent was obtained from the subjects. The data were collected under natural environmental conditions in morning (between 8 AM to 12 noon). The study was approved by the institutional ethics committee.

2) Measurement of Handgrip Strength

The handgrip strength measurement was done using a standard adjustable digital handgrip dynamometer (Takei Scientific Instruments Co., LTD, Japan) at standing position with shoulder adducted and neutrally rotated and elbow in full extension. The dynamometer was held freely without support, not touching the subject's trunk. The subjects were asked to exert maximum force on the dynamometer thrice from their hand and the average maximum value in kilograms was recorded. Anthropometric equipment and handgrip dynamometer were calibrated before each assessment. Thirty seconds time interval was maintained between each handgrip strength testing

3) Anthropometric Measurements

Anthropometric variables of the subjects were measured using the techniques provided by Lohmann et al. (1988) and were measured in triplicate with the median value used as the criterion. Subjects were weighed in minimal light-weight clothing, bare foot, using standard weighing machine. Stadiometer (Holtain Ltd. Crymych, Dyfed, UK) was used for measuring standing height. Subjects were asked to stand bare foot on horizontal surface. Heel touched the ground, counter board of stadiometer was brought down till it touches the vertex. The height of subjects was recorded in cm. The weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. Body mass index (BMI) was calculated from height and weight as follows: BMI=weight (kg) / height^2(m^2).

3. Statistical Analysis

Descriptive statistics (mean ± standard deviation) were determined for the directly measured variables as well as the derived one. One way analysis of variance was tested for the comparisons of data among the patients with T2DM and controls, followed by post-hoc Bonferroni test. Correlation coefficients of dominant and non-dominant handgrip strength with other variables were done using SPSS (Statistical Package for Social Science) version 20.0. A 5% level of probability was used to indicate statistical significance.

4. Results

1) Descriptive statistics of dominant and non-dominant handgrip strength and selected anthropometric variables of patients with T2DM and controls were shown in Table 1. One way ANOVA showed significant between-group differences ($p \leq 0.001$) in all the variables studied, among these four sets of population. When sex differences were compared, significant differences ($p \leq 0.001$) were found in all the variables studied between male and female patients with T2DM.

Table 1: One way ANOVA of handgrip strength and selected anthropometric variables in patients with type 2 diabetes mellitus and controls

Variables	DM (n=216)		DF (n=325)		CM (n=152)		CF (n=288)		F- value	p- value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
DHGS (kg)	23.23	5.16	16.04	3.69	26.82	6.09	18.57	9.96	110.56	**≤0.001**
NDHGS (kg)	20.35	5.32	13.60	3.63	23.61	6.34	15.40	3.89	212.14	**≤0.001**
Age (years)	55.98	7.87	52.78	8.27	53.69	8.69	51.51	8.90	12.08	**≤0.001**
HT (cm)	171.68	5.53	156.72	4.74	171.88	4.70	156.51	5.05	701.31	**≤0.001**
WT (kg)	77.09	12.02	67.98	10.39	73.82	11.51	68.15	13.10	34.97	**≤0.001**
BMI (kg/m²)	26.13	3.74	27.67	4.10	24.96	3.63	27.79	5.11	20.31	**≤0.001**

DM = Diabetic males, DF = Diabetes females, CM = Control males, CF = Control females, DHGS = Dominant handgrip strength, NDHGS = Non-dominant handgrip strength, HT = Height, WT = Weight, and BMI = Body Mass Index.

2) The correlation coefficients of dominant handgrip strength with selected anthropometric variables in patients with T2DM were shown in Table 2. Dominant handgrip strength had significantly positive correlations ($p \leq .018=0.001$) with non-dominant handgrip strength, weight and BMI, and significantly negative correlations ($p \leq 0.001$) with age in male patients with T2DM. In case of female patients with T2DM, dominant handgrip strength had significantly positive correlations ($p \leq 0.001$) with non-dominant handgrip strength, height, weight and BMI, and, once again, significantly negative correlations ($p \leq 0.001$) with age.
3) Table 3 showed the correlation coefficients of non-dominant handgrip strength with selected anthropometric variables in patients with T2DM. In male patients with T2DM, non-dominant handgrip strength had significantly positive correlations ($p \leq 0.035$) with weight and BMI, and significantly negative correlations ($p \leq 0.001$) with age. In case of female patients with T2DM, non-dominant handgrip strength had significantly positive correlations ($p \leq 0.009$-0.001) with height, weight and BMI, and significantly negative correlations ($p \leq 0.001$) with age.

Table 2: Correlation coefficients of right dominant handgrip strength with selected anthropometric variables in patients with type -2 diabetes mellitus

Variables	Diabetic males (n=216)		Diabetic females (n=325)		Combined (n=541)	
	r	p	r	p	r	P
NDHGS (kg)	0.911	**<0.001**	0.866	**<0.001**	0.932	**<0.001**
Age (years)	-0.246	**<0.001**	-0.304	**<0.001**	-0.087	**<0.043**
HT (cm)	0.015	0.124	0.224	**<0.001**	0.591	**<0.001**
WT (kg)	0.187	**<0.006**	0.259	**<0.001**	0.395	**<0.001**
BMI (kg/m^2)	0.161	**<0.018**	0.182	**<0.001**	0.009	0.829

NDHGS = Non-dominant handgrip strength, HT = Height, WT = Weight, and BMI = Body Mass Index

Table 3: Correlation of left non-dominant handgrip strength with selected anthropometric variables in in patients with type -2 diabetes mellitus

Variables	Diabetic males (n=216)		Diabetic females (n=325)		Combined (n=541)	
	r	p	r	p	r	P
Age (years)	-0.217	**<0.001**	-0.303	**<0.001**	-0.086	**<0.046**
Height (cm)	0.037	0.586	0.247	**<0.001**	0.557	**<0.001**
Weight (kg)	0.143	**<0.035**	0.235	**<0.001**	0.363	**<0.001**
Body mass index (kg/m^2)	0.144	**<0.035**	0.144	**<0.009**	-0.004	0.933

5. Discussion

1) Diabetes mellitus is usually associated with mild to moderate hand muscle weakness with peripheral sensory neuropathy (Redmond et al., 2009). Number of studies related to the evaluation of muscle strength in patients with diabetes mellitus were carried out on lower extremity, but not much literature is available on upper extremity in patients with the metabolic disorder. In the present study, significant differences were noted in right dominant and left non-dominant handgrip strength where patients with T2DM had the lower mean values than controls, using hand held dynamometer (97% of samples of the present study were right hand dominant). The findings of the present study followed the direction of the findings of Cetinus et al. (2005). Results of the study are also in close agreement with authors who stated that type-2 diabetes mellitus seems to result in a decrease in handgrip strength in both male and female subjects Ezema et al. (2012). It has been proposed that the post-prandial muscle protein synthetic response may be reduced in an insulin resistant state leading to a greater reduction of muscle mass in elderly patients with type-2 diabetes (Guillet and Boirie, 2005; Pereira et al., 2008). Type-2 diabetic subjects, even with high body mass indices, have shown diabetes related muscle weakness (Balogun et al., 1991; Bohannon et al., 2001; Clerke and Clerke, 2001). According to Helmersson et al. (2004) this results due to insulin resistance and hyperglycaemia, which lead to reduction in the number mitochondria in the muscle cells, lowering of glycogen synthesis and elevated levels of circulating systemic inflammatory cytokines, all of which have a damaging effect on skeletal muscles.
2) When sex differences were studied, male patients with T2DM had the significantly higher value in right dominant and left non-dominant handgrip strength than their female counterparts. The findings, once again, fallowed the results of Mathiowetz et al. (1985).
3) Infect, several factors affect the values of handgrip strength. These factors are gender (Mathiowetz et al., 1985), age (Balogun et al. (1991), hand dominance (Peterson et al., 1989), height and body weight (Crosby et al., 1994). The findings of present study indicated significant positive correlations of dominant and non-dominant handgrip strength with height, weight and BMI. The findings of the present study fallowed the earlier studies of Balogun et al. (1991), Crosby et al. (1994) and Peterson et al. (1989).
4) In hand surgeries, evaluation of handgrip strength in patients with T2DM is important. Normative values of handgrip strength was developed in normal healthy populations in earlier studies (Bassiy and Harries, 1993; Mathiowetz et al.,1985; Balogun et al., 1991; Koley and Melton, 2010).

6. Conclusion

As significant lower handgrip strength was reported in the patients with T2DM, both in males and females, proper hand exercise program may be planned for the patients with T2DM to cope with the disabilities of their day-to-day lives.

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