Original Article

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Handgrip Strength in Patients With Type 2 Diabetes Mellitus

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Abstract

Background: Handgrip strength can be used to determine an individual's muscular strength objectively. It is a valid indicator of the disability index. Type 2 diabetes mellitus has a negative impact on skeletal muscles and handgrip strength. The goal of this study was to compare type 2 diabetic patients' handgrip strength to that of apparently healthy non-diabetic individuals.

Materials and Method: This cross-sectional study was carried out in the Department of Physiology, Sylhet M.A.G Osmani Medical College in collaboration with Outpatient Department of Endocrinology, Sylhet M.A.G Osmani Medical College Hospital and Outpatient Department of Sylhet Diabetic Hospital during the period from January 2017 to December 2017. A total of 100 type 2 diabetic patients who had been diagnosed for at least 5 years were selected, as well as 100 age and sex matched apparently healthy non-diabetic controls. The Jamar Hydraulic Hand Dynamometer was used to measure the handgrip strength of all subjects. All the collected data were compiled and analyzed using the Statistical Package for Social Science (SPSS) Version 22.0.

Results: The mean handgrip strength of the diabetics (60.62 ± 18.98 lb) was significantly lower than non-diabetics (74.80 ± 21.61 lb) ($p<0.001$). A significant negative correlation was found between handgrip strength and duration of diabetes ($r=–0.270$, $p=0.007$).

Conclusion: Handgrip strength is lowered in patients with type 2 diabetes compared to the non-diabetic group and correlates negatively with diabetes duration. Reduced handgrip strength may lead to the development of impairment in the future, resulting in decreased productivity.

Keywords: Handgrip strength, Type 2 Diabetes Mellitus, Functional disability

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Introduction

T2DM accounts for about 90% to 95% of all diagnosed diabetes in adult.[1] It is one of the most common risk factors for functional disability in older individuals, especially after a long period of illness.[2]

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Because of several hand issues, patients with T2DM have been documented to be more impaired in self-care and other daily living activities than non-diabetic people.[3]Handgrip strength measurements are frequently used to assess upper limb muscular strength.[4]Handgrip strength (HGS) is the maximum force exerted by all fingers during powerful voluntary flexion under normal biokinetic conditions.[5]It is a physiological parameter that is influenced by a number of variables such as age and gender. Additionally, lifestyle and profession may have an effect on HGS.[6]Low handgrip strength is linked to functional impairments and is a strong predictor of disability in the future.[7]It is quick, simple to do, and reliable, and delivers an easily-recordable result. The hand dynamometer is used to determine the strength of the hand grip.[8]

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Studies showed that many patients develop peripheral diabetic neuropathy within five years of diagnosis.[9] If a diabetic patient's handgrip strength is measured at the point of diagnosis and routine monitoring is performed during subsequent clinical visits, muscle function deterioration can be identified very early and preventative measures such as resistance training exercise can be initiated to slow the rate of muscle function and disability deterioration before it is too late. Many studies on HGS of T2DM patients suggest the negative effect of the disease. [8,10] However, in Bangladesh, the effect of T2DM on HGS has never been evaluated.

This study provides a quantitative assessment of handgrip strength in type 2 diabetic patients, as well as the influence of long term T2DM on handgrip strength by comparing it to the HGS of age and sex matched apparently healthy non diabetic subjects.

Materials and Method

This cross sectional study was approved by ethical committee of Sylhet M.A.G Osmani Medical College Hospital. All diagnosed type 2 diabetic patients in the age group 35-65 years, with duration of diabetes at least 5years, attending the Outpatient Department of Endocrinology, Sylhet M. A. G Osmani Medical College Hospital and Outpatient Department of Sylhet Diabetic Hospital during the study period were the target population. One hundred (100) type 2 diabetic patients were enrolled as study group (Group-A). Age-sex matched apparently healthy non diabetic subjects were selected from hospital staffs and the attendants of the patients as control group (Group-B). All diabetic subjects were on hypoglycaemic agents like insulin, sulfonylureas, metformin, thiazolidinediones etc. Participants with a history of shoulder, arm, or hand discomfort, stroke, peripheral nerve damage, or cervical radiculopathy in the past 6 months were excluded from the study. None of the subjects worked in a job that required manual handling and could affect their grip. All of the subjects gave their informed written consent.

Demographic information in the form of questionnaire was taken from each subject. Age was calculated in years to nearest half year. Weight was recorded in kilograms with the subject standing on the weighing machine without shoes and minimum clothing. The same weighing machine was used to record the weights of patients and controls. Height was measured with the individual barefooted, feet together, back and heels against the height scale's upright bar; head upright with eyes in horizontal plane — stare straight ahead. The height measurement apparatus consisted of a vertical bar attached to a horizontal bar that was snugly placed on the examinee's head. Body Mass Index (BMI) was calculated in the formula, BMI=Weight in Kilogram's/Height in meters^2.

After an overnight fasting of 10-12 hours, about 5 ml of whole blood was collected via vena puncture with the help of a disposable syringe in between 7.00am and 8.00 am from all study subjects and a second sample of blood was collected from control subjects after intake of 75 gm of glucose in 250 ml water. Plasma glucose of both samples was estimated in control subjects to screen Diabetes mellitus and impaired glucose tolerance as per American Diabetes Association criteria. Serum creatinine level of all participants was estimated to screen chronic kidney disease.HGS of dominant hand was recorded using the Jamar Hydraulic Hand Dynamometer. The American Society of Hand Therapists' (ASHT) recommendation for testing grip strength was followed. The participants sat in an armless chair with their shoulders adducted and neutrally rotated, their elbows flexed at 90 degrees, and their forearms and wrists in a neutral position. Each individual was given a demonstration of maximum handgrip strength before being asked to perform it on their own. Participants were told to squeeze the handle as hard as they possibly could. The effort lasted no longer than 5 seconds. Between three trials for the dominant hand, a 30-second rest interval was given, and the average of the three trials was taken. Hand Grip strength was recorded in pounds. All the collected data were compiled and analyzed using the Statistical Package for Social Science (SPSS) Version 22.0.

Quantitative data were analyzed by mean and standard deviation and comparison was done using student's 't' test. Qualitative data were expressed as frequency and percentage and comparison was done using Chi-Square ($\chi 2$) test.

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Correlation was done by Pearson's Correlation test. A probability value (p) of less than 0.05 was considered statistically significant.

Results

One hundred (100) diabetic (group-A) and one hundred(100) non diabetic healthy subjects (group-B) were included in this study.The mean age of Group-A was 49.06 ± 7.05 years; whereas the mean age of the non-diabetic control subjects was 49.07 ± 7.28 years(p=0.992) (Table-I).

The mean BMI (Kg/M^2) of the diabetic patients was 25.21 ± 3.42 (range 18.7-38.0); whereas the mean BMI of the non-diabetic control subjects was 24.27 ± 2.16 (p=0.021) (Table-II).

Table I. Distribution of participants by age and sex

Parameters	Study subjects		p-value
	Group-A (n=100) Mean ± SD	Group-B (n=100) Mean ± SD	
Age (Mean±SD years)	49.06 ± 7.05	49.07 ± 7.28	†p=0.992
Sex			*p=1.000
Male	50(50.0)	50(50.0)	
Female	50(50.0)	50(50.0)	

Chi-Square test (X^2) and Unpaired 't' test were used to analyse the data.

Figures in the parenthesis denote corresponding percentage.

Table II. Comparison of participants by anthropometric status

Parameters	Study subjects		p-value
	Group-A (n=100) Mean ± SD	Group-B (n=100) Mean ± SD	
Height (Cm)	159.18 ± 9.70	160.12 ± 9.35	0.486
Weight (Kg)	63.73 ± 9.64	62.28 ± 8.19	0.253
BMI (Kg/M^2)	25.21 ± 3.42	24.27 ± 2.16	0.021

Student's't' test was performed to calculate the data between two groups.
Group A: Diabetic; Group B: Control

The mean HGS (lb) of the diabetic patients was 60.62 ± 18.98 (range, 20.0-103.33); whereas the mean HGS of the non-diabetic control subjects was 74.80 ± 21.61(range, 35.0-115.0). The mean HGS of the diabetic patients was significantly lower compared to non-diabetic control subjects (p<0.001) (Figure-1).

Figure-2 shows significant negative correlation between age and handgrip strength in type 2 diabetic subjects (Pearson's correlation coefficient: r=–0.391; p<0.001).

Figure-3 shows significant negative correlation between age and handgrip strength in non-diabetic subjects (Pearson's correlation coefficient, r=-0.303; p=0.002).

Figure-4 shows no significant correlation between BMI and handgrip strength in type 2 diabetic patients (Pearson's correlation coefficient, r=–0.183; p=0.068).

Figure-5 shows significant negative correlation between BMI and handgrip strength in non-diabetic subjects (Pearson's correlation coefficient, r=–0.221, p=0.027).

Figure-6 shows significant negative correlation between duration of diabetes and hand grip strength (Pearson's correlation coefficient, r=–0.270, p=0.007).

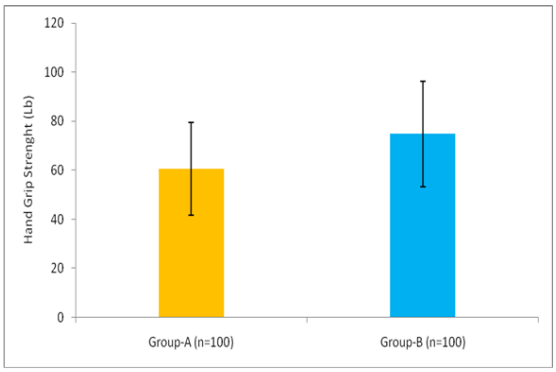

Figure-1. Comparison of handgrip strength status between two groups.
Student's 't' test was performed to analyse the data.
Group A: Diabetic; Group B: Control

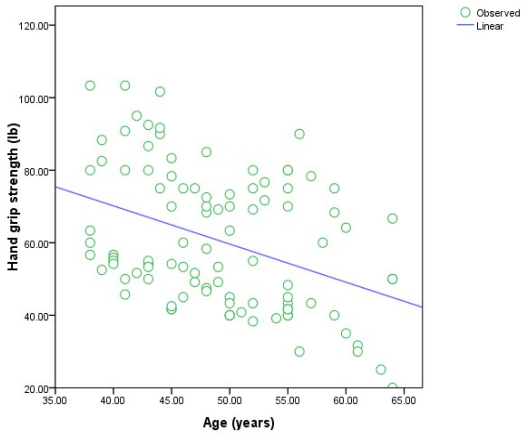

Figure 2. Scattered diagram showing Pearson's correlation analysis between age and handgrip strength in type 2 diabetic subjects (n=100)

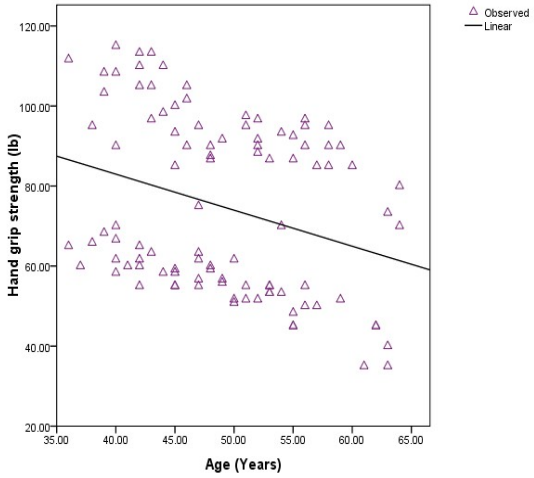

Figure 3. Scattered diagram showing Pearson's correlation analysis between age and handgrip strength in non-diabetic subjects (n=100)

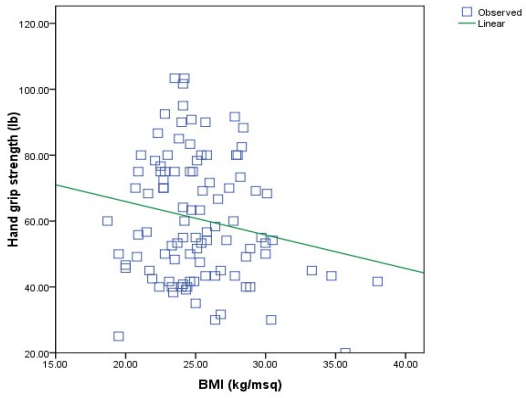

Figure 4. Scattered diagram showing Pearson's correlation analysis between BMI and Handgrip strength in type 2 diabetic patients (n=100)

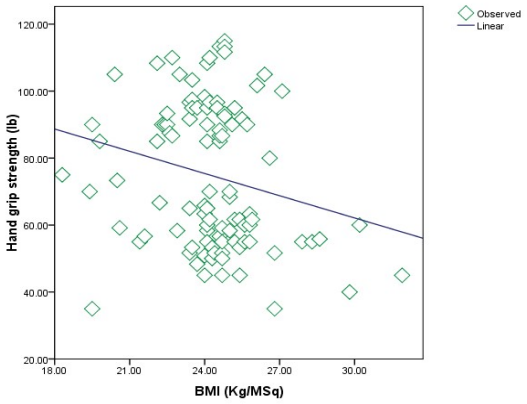

Figure 5. Scattered diagram showing Pearson's correlation analysis between BMI and hand grip strength in non-diabetic subjects (n=100)

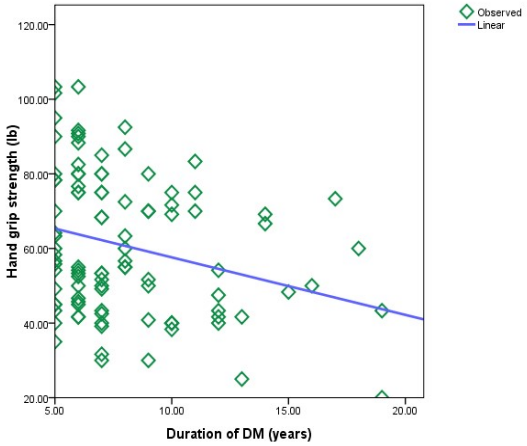

Figure 6. Scattered diagram showing Pearson's correlation analysis between duration of diabetes and handgrip strength (n=100)

Discussion

Grip strength is an important parameter of hand function. It was commonly used to evaluate the integrated performances of hand muscles by determining maximal grip force that could be produced in one muscular contraction. HGS can be used to determine a treatment, to assess nutrition, to assess risk of mortality in people with an acute illness, as a prognostic factor, and as a marker for general muscle strength.[10]Diabetes mellitus is frequently linked with mild hand muscle weakness due to peripheral sensory neuropathy.[10] Numerous studies have demonstrated a considerable loss in grip strength in the diabetic population.[10,12,13,14]

In this study the age of the diabetic patients ranged from 38 to 64 years with the mean age of 49.06 ± 7.05 years; whereas the age of the non-diabetic control subjects ranged from 36 to 64 years with the mean age of 49.07 ± 7.28 years. The mean age of the participants did not differ significantly between diabetic and non-diabetic control subjects (p=0.992).This study showed that 50.0% patients were male and 50.0% patients were female in diabetic group; similarly 50.0% patients were male and 50.0% patients were female in non-diabetic group. Exactly similar sex distribution was in both groups (p=1.000). In the present study the mean BMI of diabetic patients was significantly higher than that of non-diabetic control subjects (p=0.021). Similar observation was reported by another investigator.[15]This study showed that the mean HGS (lb) of the diabetic patients was 60.62 ± 18.98 whereas the mean HGS of the non-diabetic control subjects was 74.80 ± 21.61. The mean HGS of the diabetic patients was significantly lower compared to non-diabetic control subjects (p<0.001).Ibrahim et al [11] studied HGS in type 2 diabetic and non diabetic subjects. The mean HGS (lb) in right hand of the diabetic patients was 48.9 ± 8.5 and the mean HGS in right hand of the non-diabetic subjects was 67.5 ± 5.3. The mean HGS of the diabetic patients was significantly lower compared to non-diabetic control subjects (p=0.001). Akanksha et al[13] found that the mean HGS (Kg) of the diabetic patients was 19.347 whereas the mean HGS of the non-diabetic subjects was 35.07.The mean HGS of the diabetic patients was significantly lower compared to non-diabetic control subjects (p=0.001). This result was also consistent with the finding of Cetinus et al[10] that the diabetes group's HGS was considerably lower than the control group's (p<0.05).Ezema et al[12]discovered significant variations in mean HGS between diabetes and non-diabetic male individuals (p<0.004), as well as between diabetic and non-diabetic female subjects (p<0.002). Özdirenç et al[16]studied physical fitness in type 2 diabetes mellitus and discovered that type 2 diabetic patients had a lower physical functional capacity than age-matched healthy control subjects.HGS was found to be decreased in people with T2DM.The results of our HGS were comparable to those of Özdirenç et al.[16] Individuals with T2DM have lower handgrip strength, according to Rantanen et al[17] and Leveille et al.[18]Savas et al[19]came to the same conclusion, noting that diabetics had significantly lower HGS than non-diabetic controls (p<0.05). The findings of this study are also in line with the findings of the authors, who claim that type 2 diabetes causes a loss in HGS in both male and female patients. People with T2DM may be less productive due to this physical limitation.[20] Gill et al[21]discovered that persons with long-standing T2DM have significantly poorer handgrip strength than age- and sex-matched controls. Fittzgibbons and Weiss [3]found comparable results in diabetic patients with lower handgrip strength. Park et al[20]found a link between muscle quality and the duration of T2DM.The findings of this study are consistent with those of another study, which found that T2DM causes a decrease in HGS.[12]Insulin resistance could have contributed to muscular weakness and, thus, to decreased grip strength.[22]

This study showed a significant negative correlation between age and HGS in both type 2 diabetic subjects (r=-0.391; p<0.001) and non-diabetic subjects (r=-0.303; p=0.002). Cetinus et al [10]also found a negative correlation between age and HGS in both type 2 diabetic subjects and non diabetic subjects. In type 2 diabetic individuals, there was no significant negative correlation between BMI and HGS (r=-0.183; p=0.068), while there was a significant negative correlation between BMI and HGS in non-diabetic subjects (r=-0.221, p=0.027) in this study. Cetinus et al[10] showed that the link between BMI and HGS was not significant (p>0.05) in either the diabetes or control group.There was a significant negative correlation between diabetes duration and handgrip strength in this study (r=-0.270, p=0.007). Pawalia et al[8]discovered a week negative correlation between grip strength and diabetes duration, i.e., as diabetes duration rises, grip strength declines. According to Ezema et al,[12]long-standing T2DM appears to result in a loss in HGS in both males and females.The significant decrease in muscle strength observed in diabetics when compared to age-matched healthy individuals is explained by two mechanisms: increased insulin tissue resistance

and hyperglycaemia, which result in a decrease in the number of mitochondria in muscle cells, a decrease in glycogen synthesis, and an increase in circulating systemic inflammatory cytokines, which have a negative effect on the skeletal muscles.[23]Another possible cause of muscle weakness is a long-standing T2DM-related subclinical neurological condition involving motor neurons.[21,24]Additionally, patients with diabetes have a dramatically reduced cross section of the muscles, which is exacerbated by a prolonged period of illness and poorer control.[25]In roughly 50% of persons with type 2 diabetes, the metabolic abnormalities associated with T2DM induce damage to the connective tissues of the hand, resulting in limited joint range of motion, dupuytren's contracture, and flexor tenosynovitis.[19,25]

In our study the participants were mostly housewives, teachers, businessman, bankers, physicians or office clerks. None of them were involved with heavy work or regular physical exercise. None of them were clinically anaemic.

Conclusion

Diabetics had significantly lower mean handgrip strength than non-diabetics. The negative relationship between HGS and diabetes duration further supports the notion that it decreases in diabetics. In those with long-term T2DM, these characteristics may have a role in upper-limb functional limitations and physical impairment.Assessment of HGS in diabetics may aid in the diagnosis and rehabilitation of impairment.To make a conclusive statement about this subject, additional research with stratified groups of diabetics and control people is necessary.

Limitations of the Study

Sample size in this study was limited due to limited study period;glycaemic status of the diabetic patients was not evaluated; NCT(Nerve Conduction Test) of the participants was not performed.

Recommendations

Timely assessment of handgrip strength in diabetics can help in detection of disability and proper rehabilitation and the value of such strategies should be evaluated in further studies involving multicentre and large populations of type 2 diabetes mellitus. Glycaemic status and NCT should also be included in the study.

Conflict of Interest

Authors have no conflict of interest.

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