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RESEARCH ARTICLE

UNDERSTANDING THE GENDER DIFFERENCES IN HAND GRIP STRENGTH OF PATIENTS WITH TYPE 2 DIABETES MELLITUS (T2DM) COMPARED TO SUBJECTS WITHOUT T2DM IN CLINIC SETTINGS

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Abstract

Type 2 Diabetes Mellitus is a metabolic disease with myriad complications. Some of these consequences are less studied than the rest. This study aimed to investigate the relation, if any, between T2DM and Hand Grip Strength, via a case-control method utilising convenience sampling. The hand grip strengths of 40 subjects, 20 afflicted with the condition, and 20 control, were tested using the JAMAR Dynamometer. Their basic parameters (age, height, weight, BMI, etc) were recorded, and the duration of diabetes as well as HbA1c and Fasting Glucose levels were also considered for the case subjects. The study also examined the gender differences in hand grip strength across groups. Results are consistent with the findings of various other studies which display that Type 2 Diabetes Mellitus markers have a negative correlation with hand grip strength, and hence, muscle strength in general. Both case and control groups exhibited significant gender discrepancies in hand grip strength, and the impact of gender was found to be stronger in the control group than in the T2DM afflicted group. Future research should be conducted in order to determine whether low hand grip strength can be considered a symptom of T2DM, and hence, assist in its diagnosis. Low grip strength should also be investigated as a marker for control in diabetes, or an indicator that a change in medical regimen, diet, exercise, etc. is required.

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Introduction:-

This study aims to investigate the gender differences in hand grip strength of patients with Type 2 Diabetes Mellitus in clinic settings and compare the results with those of subjects unafflicted by the disease.

Key Terms:

i. Type 2 Diabetes Mellitus

Type 2 Diabetes Mellitus (T2DM) is a condition in which the body does not produce enough insulin to properly utilise the increased levels of glucose. The primary cause for this type of diabetes is the patient's lifestyle- sugar intake, diet, exercise, etc., though it can also be caused by genetic history, or problems in the pancreas such as

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pancreatitis, in which the gland does not secrete enough insulin. In this scenario, glucose can enter the bloodstream and the urine, causing various complications relating to various parts of the body, i.e., the kidney, the retina, the liver, the nerves, and the heart. There has been a huge upward trend of people suffering from T2DM, from as early as 25 years of age. This study aims to discover the relation between this condition, and muscular/ hand grip strength, as well as the gender differences it possibly exacerbates.

Factors relating to T2DM include weight/obesity, family history of diabetes, age, blood lipid levels, polycystic ovary syndrome, lack of physical activity, a high glucose diet, and lifestyle (smoking habits, etc). Various known complications of T2DM include heart and blood vessel disease, nerve damage/neuropathy, kidney disease/nephropathy, eye damage/retinopathy, non-alcoholic fatty liver disease.

Decrease in Hand Grip strength is also a proposed complication of this condition, and we aim to study this through patients attending the diabetes clinic at Fortis C-DOC by observing and comparing the hand grip strength in T2DM patients, and non-diabetics, as well as attempting to understand the gender differences.

HbA1c

The Haemoglobin A1c test is a test of glycated haemoglobin, which reveals the glucose levels in one's blood. HbA1c is a useful quantity used to understand the level of control in diabetes or detect a tendency to get diabetes (prediabetes). It is measured as the average blood sugar levels of the subject over the previous 2-3 months.

Hand Grip Strength

Hand grip strength is a measure of muscular strength, or the maximum force/tension generated by one's forearm muscles, that can be quantified by measuring the amount of static force that the hand can squeeze around a dynamometer. This produces a measure of isometric strength that allows identifying not only muscle weakness of the upper limb, but also providing an indicative of overall strength, since it reflects the strength of the lower limbs. **Grip strength is referred to as a reliable and valid objective parameter to evaluate the functional integrity of the hand as the part of the musculoskeletal system.**

It is known that hand grip strength in the dominant hand is naturally much more than the non-dominant hand. It is also believed that female hand grip strength is significantly less than male hand grip strength, and there have also been recent studies that strengthen these claims. In a study conducted in clinic settings in Mumbai, wherein grip strength was measured using a Jamar Dynamometer, it was observed that there was a significant difference in the hand grip strength of healthy males and females with the values higher in the former (Walankar, et. al., 2016). In the present research, we aim to investigate how this difference is affected by the condition of T2DM.

Literature Review:-

Multiple studies have found that Type 2 Diabetes Mellitus is associated with decreased muscle/handgrip strength. For instance, Lee, et al. (2018) reported that adults with T2DM had lower handgrip strength and normalised handgrip strength as compared to their healthy counterparts. Sarcopenia has also been associated with Type 2 Diabetes Mellitus. A study done in elderly population shows a significant association between T2DM and hand grip strength. This may be due to sarcopenia caused by T2DM as a result of insulin resistance disrupting glucose transport to the muscles. A decrease in protein synthesis results in decreased muscle mass, which can then be detected by hand grip strength measurement (Umam&Setiati, 2018). Hand grip strength test values were significantly lower in the diabetic group compared with the control group. Key pinch power value for the right hand was significantly lower in the diabetic group than in the control group whereas the left-hand value was similar (Cetinus et al., 2005).

Abdulrazzaq and colleagues (2020) reported that HbA1c does not have any significant correlation with hand grip strength in T2DM patients, but there is a negatively significant relation between HbA1c and Hand Grip Strength in non-diabetic patients. In the age groups of 41-45 years and 51-55 years, there was a weak negative correlation found between HbA1c and Hand Grip Strength (Ansari & Ruprai, 2018). All these studies seem to agree that hand grip strength is significantly lower in T2DM patients than the unaffected, and lower in afflicted females than afflicted males- it can be safely concluded that there is an association between indicators of Type 2 Diabetes Mellitus and hand grip/ general muscle strength, and this association is generally inverse, i.e., handgrip strength is inversely proportional to fasting glucose, HbA1c, and fasting insulin levels as well as the homeostasis model assessment of

insulin resistance (HOMA-IR) score. This paper will aim to conduct similar research, but among the Indian population, as well as observe the gender differences in hand grip strength in both groups.

Methodology:-

The study was conducted in the Endocrinology clinic at Fortis C-DOC Hospital for Diabetes, Metabolic Diseases and Endocrinology, B -16, Chirag Enclave, Nehru place, New Delhi - 110048.

The aim of the study was to understand the gender differences in hand grip strength of patients with Type 2 Diabetes Mellitus (T2DM) compared to subjects without T2DM in clinic settings. It was hypothesised that patients with Type 2 Diabetes Mellitus would show decreased muscular/ hand grip strength as compared to the mean value of the non-afflicted public across genders and in both hands. The grip strength of female subjects was also expected to be significantly lower than their male counterparts.

The study was conducted among 40 subjects, with comparisons drawn between males and females, as well as between T2DM patients and non-diabetic staff. As part of the Case Control Study, convenience sampling was undertaken due to the short-term nature of the project, the duration of which was 3 weeks.

For the present study, diabetic patients were recruited from the endocrine OPD at Fortis C-Doc hospital, and the non-diabetic control group consisted primarily of the hospital staff. Twenty participants in each group were enrolled.

Data Collection

Weight was recorded in kilograms using a weighing scale, height was recorded in metres using a stadiometer, and BMI was calculated as $\text{Weight} / \text{Height}^2$, in kg/m^2 . The JAMAR Dynamometer was used to measure Hand Grip Strength in kilograms, with three readings taken per subject, and the average result considered. The angle of each subject's elbow was kept as close to 90 degrees as possible, with grip strength of their dominant hand measured. Duration of diabetes was recorded as years, while HbA1c was measured as a percentage. These biochemical values were taken from the patients' records, with informed consent.

Inclusion Criteria

Patients of both genders aged between 20-70 years and afflicted with Type 2 Diabetes Mellitus that were visiting the OPD were considered for the study. The control group consisted of both male and female hospital staff members aged between 20-70 years, and **not** afflicted by the condition.

The age, weight, height, BMI, and hand grip strengths of both groups of subjects were measured and recorded. Fasting glucose levels, HbA1c, and duration of Diabetes were also considered for the experimental group.

Exclusion Criteria

Patients with any pre-existing condition that affected their muscle strength, i.e.: hand fracture, muscular dystrophy, etc were **not** considered, as they would not yield results comparable to the general public. Subjects with trauma to the upper extremity region, acute or chronic musculoskeletal disorders and a history of pain and musculoskeletal problems in the shoulder, arm, or hand were also excluded from the study. Patient-reported history of brachial plexus peripheral nerve injury, cervical radiculopathy in the previous 6 months, carpal tunnel syndrome and cervicalspondylosis was part of the exclusion criteria. Hospital staff afflicted with T2DM were not included in the control group.

Statistical Significance Testing

To investigate the significance of the results, statistical analysis was employed. T-tests were conducted to compare the mean hand grip strengths of the case and control groups, and the mean gender differences across groups, and the gender differences in each group were compared separately.

Limitations

There are some limitations to this research. As the sample size of the study is relatively small ($n=40$), the findings can not be applied reliably to the general population. Furthermore, Convenience Sampling was utilised instead of Simple Random Sampling, also making it difficult to generalise results.

Results:-

Diabetic patients that were a part of the experiment group of the study (i.e., those afflicted with Type 2 Diabetes Mellitus) had an average age of 55.1 years. On average, female subjects were older than males by around 3 years, with a mean age of 56.8 years as compared to the male average of 53.6 years. Mean weight was approximately 72.4 kilograms, with males averaging 75.6 kilograms as compared to their counterparts with a mean weight of 68.83. The mean height was 165.5 centimetres, and hence, average BMI was calculated to be 26.3 kg/m². Males were found to be generally taller than females by around 17 cm, and the female Body Mass Index was higher than that of males, with 27.8 kg/m² on average in contrast to the male mean of 24.7 kg/m². The average HbA1c percentage in the T2DM group was 8.1; 8.3% on average in females, and 8% in males. Mean fasting glucose levels were found to be around 181 mg/dL, females had an average FBG of 189 mg/dL as opposed to males' average of 174 mg/dl. Mean duration of diabetes was 10.4 years. Females had an average diabetes duration of around 11.1 years, while males had a mean duration of 9.8 years. Subjects averaged 27.2 kgs of hand grip strength on the Jamar Dynamometer, across genders. There was a marked difference observed between males and females, with females averaging significantly lower- almost half of the males' grip strength- 18.6 kgs as compared to the latter's 34.1 kgs.

Table 1:- Distribution of subjects **with** T2DM according to their anthropometric and biochemical details.

FACTORS	Males (Mean ±SD)	Females (Mean ±SD)	Total (Mean ±SD)
AGE (years)	53.6 ± 10.8	56.8 ± 8.5	55.1± 9.6
WEIGHT (kgs)	75.6 ± 12.1	68.8 ± 16.4	72.4 ± 14.3
HEIGHT (centimetres)	174.3 ± 0.1	156.7± 0.1	165.5 ± 0.1
BODY MASS INDEX (kg/m ²)	24.7 ± 3.1	27.8 ± 5.4	26.3 ± 4.5
HbA1c (%)	8.06 ± 1.5	8.3 ± 2.2	8.2 ± 1.8
FASTING BLOOD GLUCOSE (mg/dL)	174 ± 60.2	189 ± 90.7	181.1 ± 74.3
DIABETES DURATION (years)	9.8 ± 9.2	11.1 ± 7.4	10.45 ± 8.2
HAND GRIPSTRENGTH (kgs)	34.2 ± 8.2	18.7 ± 4.5	27.2 ± 10.3

In the control group, patients from 20-70 years were considered with the average age of both genders coming to an estimated 29.5 years. Female subjects were younger than their male counterparts; their average age of 26.3 years much less than that of the males, who had a mean age of 32.14 years. The mean weight of the subjects was found to be 69.3 kgs (Females; 68.4 kgs on average, and males; 70.6 kilograms) Subjects averaged 163.9 centimetres (approximately) in height. The calculated BMI of the study participants was found to be 25.6 kg/m²- males averaged 24.5 kg/m² and females averaged 26.5 kg/m². Hand Grip strength of the control group (non-diabetics) was notably more than the experimental group (diabetics), with subjects averaging 37.3 kgs approximately. There remained a huge discrepancy in grip strength between genders, with females averaging just 28.1 kgs, almost half of the mean strength of males; a much larger 50 kgs.

Table 2:- Distribution of subjects **without** T2DM according to their anthropometric and biochemical details.

FACTORS	Males (Mean ± SD)	Females (Mean ± SD)	TOTAL (Mean ± SD)
AGE (years)	32.1 ± 7.6	26.3 ± 5.3	29.5 ± 7.1
WEIGHT (kgs)	70.6 ± 11.5	68.37 ± 15.9	69.3 ± 14
HEIGHT (centimetres)	169.4 ± 0.1	160.2 ± 0.1	163.8 ± 0.1
BODY MASS INDEX (kg/m ²)	24.5 ± 1.9	26.5 ± 4.7	25.6 ± 3.9

HAND GRIP STRENGTH(kgs)	49.9 ± 7.1	28.2 ± 6.2	37.3 ± 12.7
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Patients with Type 2 Diabetes Mellitus showed decreased muscular/ hand grip strength as compared to the participants belonging to the non-diabetic group. This is consistent with the findings of various other studies which display that Type 2 Diabetes Mellitus has a negative correlation with hand grip strength, and hence, muscle strength in general. Patients with higher HbA1c and fasting blood glucose consequently also showed lower hand grip strength. This implies that lowered hand grip strength can be seen as a consequence of Type 2 Diabetes Mellitus. A statistical t-test for mean difference in the control and experimental group was conducted with a set of hypotheses as follows (with conditions for the test being met- large count, etc):

H_0 : Patients with and without Type 2 Diabetes Mellitus will show equal/similar muscular/hand grip strength.

H_a : Patients with Type 2 Diabetes Mellitus will show decreased muscular/ hand grip strength as compared to the non-afflicted public across genders.

This was conducted at a significance level of 0.05, and the resultant t-value was -2.68, with a p-value of 0.0053 (<0.05). The hand grip strength of the 20 T2DM patients ($M = 27.20$, $SD = 10.33$) was significantly low compared to the 20 participants in the control group ($M = 36.95$, $SD = 12.5$). Hence, the null hypothesis was rejected, and the alternative hypothesis was accepted. There is a statistically significant disparity in hand grip strength among the control and experimental groups.

To measure the significance of gender in Hand Grip Strength, another t-test was conducted with the below set of hypotheses:

H_0 : Female and male subjects across control and experiment groups will show equal/similar muscular/hand grip strength.

H_a : Females will show decreased muscular/ hand grip strength as compared to males across control and experiment groups.

This was conducted at a significance level of 0.05, and the resultant t-value was -5.71, with a p-value less than 0.00001 (<0.05). The hand grip strength of the 20 female subjects ($M = 23.49$, $SD = 5.21$) was significantly low compared to the 20 male subjects in both groups ($M = 42.03$, $SD = 7.66$). Hence, the null hypothesis was rejected, and the alternative hypothesis was accepted. There is a statistically significant disparity in hand grip strength among the control and experimental groups.

Two more t-tests were conducted- one comparing the grip strength differences in males and females afflicted with T2DM, i.e; the experimental group, and one comparing the mean differences in males and females in the control group. The hand grip strength of the 10 female subjects in the T2DM group ($M = 18.66$, $SD = 4.47$) was significantly lower than the male subjects ($M = 34.18$, $SD = 8.22$). The resultant t-value for the T2DM gender difference was -5.06625, with a p-value of 0.00004. The result was significant at $p < 0.05$. The hand grip strength of the 10 female subjects in the control group ($M = 28.33$, $SD = 5.95$) was significantly lower than the 10 male subjects ($M = 49.88$, $SD = 7.10$). The resultant t-value was -7.34317, with a p-value < 0.00001. The result was significant at $p < 0.05$. Comparing the p-values of the two tests, it was found that the gender difference of hand grip strength in the control group was more significant than the gender differences in grip strength of T2DM patients, as lower p-values indicate greater significance of mean difference (p-value less than 0.00001 < p-value 0.00004).

Discussion And Conclusion:-

In T2DM patients, hand grip strength in males was almost double of hand grip strength in females. There was a similar dichotomy between males and females in the non-T2DM afflicted subjects, albeit **more discrepancy**. This study also suggests that gender differences in hand grip strength are present in both T2DM and non-diabetic subjects, with female subjects scoring significantly lower on the JAMAR dynamometer test.

The hypothesis can be considered proven for the sample group; T2DM patients did display lower hand grip strength than non-diabetics, and in both groups, males showed higher hand grip strength than females. It can also be considered proven that gender plays an important role in hand grip strength. Further, the gender differences can be

proven to be more pronounced in non-T2DM patients than the case group. A possible explanation for these results could be previously studied decrease in muscle mass, and increased incidence of sarcopenia in Type 2 Diabetes Mellitus afflicted patients.

Combined with multiple previous studies that have yielded similar results, this study can be applied in various ways. Lower hand grip strength may be considered a symptom of Type 2 Diabetes Mellitus, or an indication that an afflicted patient may need a specific exercise regimen to control and mitigate muscle weakness brought on by complications of the disease.

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