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Research Article

# TO STUDY THE PREVALENCE OF SARCOPENIA IN TYPE-2 DIABETIC PATIENTS IN A RURAL TERTIARY CARE HOSPITAL

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**ABSTRACT**

**Objective:** The objective of this study was to study the prevalence of sarcopenia in type-2 diabetic population coming to a rural tertiary care hospital.

**Methods:** A cross-sectional study involving 150 participants including both outpatient and inpatient department patients was conducted at MM Institute of Medical Sciences and Research, Mullana (Ambala) between June 2021 and June 2022 after seeking appropriate permissions and approval from the Institutional Ethics Committee. Patients who consented to participation were enrolled in the study and were evaluated as per the European working group for sarcopenia in older people algorithm using bioelectrical impedance analysis and were asked to fill out a printed proforma (available in Hindi and English languages) to assess their SARC-CalF scores, handgrip strength, calf circumference and comorbidities. Patients were interviewed if they were illiterate, and responses were recorded. Statistical analyses were performed on IBM SPSS Statistics version 26.

**Results:** The overall prevalence of sarcopenia was found to be 3.3% in 150 subjects who were enrolled in the study. Among the cases (diabetics), the prevalence was 4.0% and 2.67% in the controls (non-diabetics). Mean handgrip strength was found to be 18.73 kg among cases and 19.47 kg among controls. Handgrip strength did not show a significant association with diabetes (p=0.435). Handgrip strength was not found to be significantly associated to sex. Mean gait speed (in m/s) was found to be 1.42 in a range of 0.30–2.50 with a standard deviation of 0.59. Mean gait speed was 1.87 m/s in controls and 0.96 m/s in cases. Gait speed was found to be significantly associated with diabetes (p=0.00). No significant association was seen with sex (p=0.95). Mean calf circumference was found to be 33.28 cm among cases and 34.49 cm in controls. Calf circumference was found to be significantly correlated with diabetes (p=0.00). The SARC-CalF questionnaire was shown to have a sensitivity of 40% and a specificity of 100% at the recommended threshold of ≥11. In the study group, the mean HbA1c was found to be 10.1%. Sarcopenia was not found to be significantly associated with diabetes (p=0.649). No statistically significant relationship was found between hypertension and sarcopenia (p=0.394).

**Conclusion:** Sarcopenia is largely an overlooked disease, especially in India. Various efforts to study the prevalence, causation, and effects of sarcopenia have been made, but no large-scale studies have been undertaken so far. Our study concluded that the SARC-CalF questionnaire can be used as a bedside screening tool. Though our study failed to find any statistically significant relationship between sarcopenia and diabetes, large scale studies are still warranted in this regard.

**Keywords:** Sarcopenia, SARC-CalF questionnaire, Handgrip strength, Calf circumference.

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## INTRODUCTION

Advancements in the field of science, especially in the field of healthcare, have blessed us with increasing lifespans, and the possibility of living to be octogenarians and centenaries look more possible today, than it did as recent as two decades ago. As seems consistent with the law of the universe, the flipside to this virtue of a long life is bundled with the curse of chronic diseases such as diabetes mellitus, ischemic heart disease, and many others. As a result, the prevalence of diabetes, hypertensive heart disease, and other chronic diseases have skyrocketed in the past decade or so.

Keeping pace with the financial prosperity and materialistic development, lifestyles have changed a lot. In addition to a sedentary lifestyle, the consumption of fast-food, tobacco, and alcohol is almost synonymous with the current generation. What this has done is to speed up the onset, and or, progression of various disease processes and has, in a way, contributed to the morbidity and a poor quality of life.

The International Diabetes Federation, in its tenth edition released in 2021, reported that approximately 537 million adults (20–79 years) are living with diabetes and this number is estimated to rise to 643 million by the year 2030 and to 783 million by the year 2045.

As would seem consistent with the dreaded manifestations of *Syndrome X*, or the insulin-resistance syndrome, an inverse dose-response relationship between muscle strength and insulin resistance as well as 2-h glucose levels in an oral glucose tolerance test has been reported [1].

*Sarcopenia* (loss of muscle mass) and *dynapenia* (loss of muscle strength) have recently been studied as the deathly hallows of ageing. Sarcopenia, the age-related decline in skeletal muscle mass, quality, and function, may make a significant but under-appreciated contribution to increasing the risk of type 2 diabetes. Research work has indicated a bidirectional relationship between the phenomena of sarcopenia and diabetes – implicating sarcopenia as both, a causal factor and as a sequelae of diabetes [2].

Studies have shown that engaging in muscle-strengthening activities is associated with a reduced risk of developing type 2 diabetes [3]. Recently, developed operational definitions and the inclusion of sarcopenia in the International Classification of Diseases (ICD), 10$^{th}$ revision, clinical modification, provide impetus for clinicians for diagnosis and treatment of sarcopenia in older patients.

Going by the projections and the lack of adequate studies and research in this domain of defining the role of sarcopenia in the causation and/or as a chronic sequela remains pertinent. Research work to define the prevalence and outcomes of sarcopenia associated with diabetes needs to be worked out and, thus, is the need of the hour. To indent in new

therapies and strategies in the management of both sarcopenia and diabetes. Sarcopenia and diabetes mellitus, both being diagnosable diseases as per the ICD, this inter-relationship between the two can serve as a beacon to better understanding to the etiopathogenesis, management, and progression of either.

## METHODS

### Study setting

The study included patients with type 2 diabetes admitted under various clinical departments of MMIMSR, Mullana, Ambala. Non-diabetic age and sex-matched controls meeting the inclusion criteria were selected.

### Sample size

Sample size calculated according to the formula $4pq/d^2$, where "p" is the prevalence, "q" is (1-p), and "d" refers to the maximum permissible error. The prevalence was found to be around 10% and the sample size was found to 144, which will be rounded off to 150.

### Study design

A case-control study design was adopted, where the cases were taken to be previously diagnosed as well as newly diagnosed patients of DM (as per the inclusion criteria), and controls were age- and sex-matched non-diabetic patients. Patients of both controlled and uncontrolled DM were included in the study.

### Study tools

a. SARC-calf questionnaire
b. Measuring tape
c. Body composition analyzer (for bioelectrical impedance [BI] analysis)
d. Handheld dynamometer (for HGS).

### The SARC-CalF questionnaire

The questionnaire consisted of five questions which addressed the five domains of strength, assistance in walking, rising from a chair, and climbing stairs and history of falls. Each question was to be answered on a scale of 0–2, where,

- 0 refers to "no difficulty"
- 1 Refers to "some difficulty"
- 2 Refers to "inability."

In addition to the questions, calf circumference was measured. Females having a circumference of ≤33 cm were scored as 10 and more than 33 cm was scored as 0. The cutoff point for males was taken as ≤34 cm and they were scored as 10.

- Q.1) How much difficulty do you have in lifting and carrying a weight off 10 lbs. (~4.5 kg)
- Q.2) How much difficulty do you have in walking across a room?
- Q.3) How much difficulty do you have in transferring from a chair to bed?
- Q.4) How much difficulty do you have in climbing a flight of 10 stairs?
- Q.5) How many times have you fallen in the last year? (0 falls: 0/1–3 falls: 1/>3 falls: 2)

A score of 0–10 was not suggestive of sarcopenia, whereas a score between 11 and 20 was taken as sarcopenia.

### Handheld dynamometer

For measurement of handgrip strength (dynapenia), we used a handheld dynamometer with the least count of 0.1 kg (100 g).

### Body composition analyzer

For measurement of appendicular skeletal mass, we used the *Omron HBF-222T* body composition analyzer. HBF-222T measures the body fat percentage by the BI method. Muscles, blood vessels, and bones are body tissues with a high-water content that conducts electricity easily. Body fat is tissue that has little electric conductivity. The unit sends an extremely weak electrical current of 50 kHz and <500 μA through your body to determine the amount of fat tissue. This weak electrical current is not felt while operating the unit. For the scale to determine the body composition, it uses the electrical impedance, along with the height, weight, age, and gender information to generate results.

The machine had an accuracy of ±0.4 kg (2.0–40.0 kg)/±1% (40.0–150 kg) and an accuracy of 3.5% while measuring muscle percentage.

### Methodology

- Six components – Strength, assistance with walking, rising from a chair, climbing stairs, history of falls, and calf circumference were self-recorded by the patient
- Calf circumference was given a score of 0–10 and other domains were scored on a scale of 0–2, with a maximum score of 20
- Subjects were evaluated according to the European working group for sarcopenia in older people algorithm. First, the patient was asked to walk a predefined distance (5 m) and gait speed was evaluated
- If gait speed came out to be >0.8 m/s, handgrip strength was measured. A handgrip strength of <27 kg for males and <16 kg for females was deemed as low and patient was subjected to bioelectric impedance analysis for estimation of skeletal muscle mass
- If gait speed came out to be ≤0.8m/s, the patient was taken for estimation of skeletal muscle mass directly
- Appendicular skeletal muscle mass ≤20 kg/$m^2$ for males and ≤15 kg/$m^2$ for females was diagnosed as sarcopenia.

### Inclusion criteria

The following criteria were included in the study:

1. All age groups were included in the study
2. Previously diagnosed cases of type-2 DM, on OHA's or an insulin therapy
3. Newly diagnosed of diabetes mellitus with HbA1c values of more than, equal to 6.5.

### Exclusion criteria

The following criteria were excluded from the study:

1. People unwilling to participate in the study
2. Critically ill hemodynamically unstable patients
3. Patients with coexisting malignancy/cachexia/CLD/ESRD/tuberculosis
4. Patients in whom complete data could not be obtained.

### Statistical analysis

Data entry was done using Microsoft Excel and analyzed using IBM SPSS Statistics version 26. Pearson's Chi-square test was used to analyze differences in demographic and other characteristics for categorical parameters. Descriptive statistics, including means and standard deviations, medians, and interquartile range, were used to summarize the various characteristics of the study participants. $p<0.05$ was regarded as being statistically significant.

### Ethical statement

Approval for this study was received by Ethics and Research Committee, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Ambala. All the patients enrolled in the study were asked to provide written informed consent.

## RESULTS AND DISCUSSION

This study included 75 cases of diabetes and 75 age- and sex-matched controls (non-diabetics) after prior consent. Mean age of the study population was 49.34 years, of which 41.3% (n=62|31 cases and 31 controls) and 58.7% (n=88|44 cases and 44 controls) were female and male, respectively.

Mean age (in years) was 49.34, of which minimum age was 29 years and maximum age was 70 years. About 21.3% of the patients (n=32) were below the age group ≤ 40 years, 61.3% of the patients (n=92) were in

| | Non-diabetic | | Diabetic | | Total |
|---|---|---|---|---|---|
| | Number of controls | Percentage | Number of cases | Percentage | |
| Age group (years) | | | | | |
| ≤40 | 16 | 21.3 | 16 | 21.3 | 32 |
| 41–59 | 46 | 61.3 | 46 | 61.3 | 92 |
| ≥60 | 13 | 17.3 | 13 | 17.3 | 26 |
| Total | 75 | 100 | 75 | 100 | 150 |

the age bracket 41–59 years, and 17.3% (n=26) were aged 60 years and above.

In a study conducted by Mainous *et al*., handgrip strength was shown to be lower in diabetics than non-diabetics [4]. Overall, mean HGS was found to be 19.10 kg and did not show a significant correlation with diabetes (p=0.435). No significant difference in handgrip strengths was observed between the sexes.

| HGS (kg) | Non-DM (controls) | | Diabetic (cases) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| | 19.47 | 5.95 | 18.73 | 5.62 |

| Relationship of handgrip strength with diabetes mellitus | | |
|---|---|---|
| | Value | p-value |
| Pearson's R | −0.064 | 0.435 |

Overall, mean gait speed (in m/s) was found to be 1.42 with a minimum of 0.30 and maximum of 2.50 and a standard deviation of 0.59. Gait speed was found to be significantly associated with diabetes with a p=0.00. No significant association was seen with sex.

| | Non-DM (controls) | | Diabetic (cases) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Gait speed (m/s) | 1.87 | 0.38 | 0.96 | 0.37 |

| Relationship of gait speed with sex | | | |
|---|---|---|---|
| | Value | Degrees of freedom | p-value |
| Pearson Chi-Square | 28.493 | 22 | 0.160 |

| Relationship of gait speed with diabetes | | |
|---|---|---|
| | Value | p-value |
| Pearson's R | −0.771 | 0.000 |

Mean skeletal muscle mass percentage and mean appendicular skeletal mass was found to be 38.10% and 24.3239 kg, respectively. Diabetes was found to be significantly associated with skeletal muscle percentage (p=0.015), but not with appendicular skeletal mass (p=0.534).

| | Non-DM (controls) | | Diabetic (cases) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| SMM% | 38.7013 | 2.90 | 37.5053 | 3.06 |

| Relationship between SMM% with diabetes | | |
|---|---|---|
| | Value | p-value |
| Pearson's R value | −0.198 | 0.015 |

| | Non-DM (controls) | | Diabetic (cases) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Appendicular skeletal muscle mass (kg) | 24.5350 | 4.31925 | 24.1129 | 3.96106 |

| Correlation of appendicular skeletal muscle mass with diabetes | | |
|---|---|---|
| | Value | p-value |
| Pearson's R | −0.051 | 0.534 |


**Fig. 1: Handheld dynamometer**

The mean calf circumference was found to be 33.89 cm in our study population. A study conducted by Zhang *et al*. showed calf circumference to be significantly associated with insulin resistance [5]. Our study found calf circumference to be significantly correlated with diabetes (p=0.00).

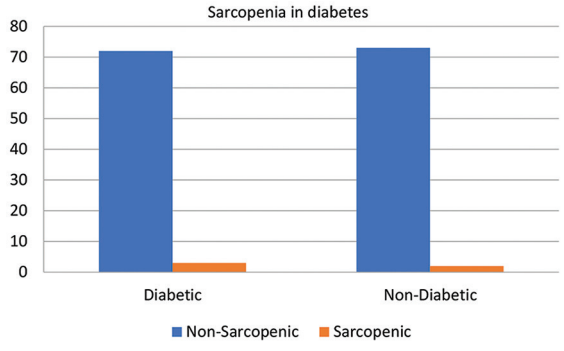
| | Non-DM | | Diabetic | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Calf circumference (cm) | 34.49 | 1.71 | 33.28 | 1.95 |

| Correlation of calf circumference with diabetes | | |
|---|---|---|
| | Value | p-value |
| Pearson's R | -0.316 | 0.000 |

| | | |
|---|---|---|
| **Product Category** | **Body Composition Analyzers** | |
| **Product Description** | **Body Composition Monitor** | |
| **Model (code)** | **HBF-222T (HBF-222T-APW/HBF-222T-INW)** | |
| **Display*** | **Body Weight:** | 2.0 to 150.0 kg with an increment of 0.1 kg |
| | **Body Fat percentage:** | 5.0 to 50.0% with an increment of 0.1% |
| | **Skeletal Muscle percentage:** | 5.0 to 60.0% with an increment of 0.1% |
| | **BMI:** | 2.5 to 90.0 with an increment of 0.1 |
| | **Resting Metabolism:** | 385 to 3999 kcal with an increment of 1 kcal |
| | **Body Age:** | 18 to 80 years old with an increment of 1 year |
| | **Visceral Fat Level:** | 30 levels with an increment of 1 level |
| | **Body fat percentage, Skeletal muscle percentage and BMI classification:** – (Low) / 0 (Normal) / + (High) / ++ (Very High) 4 levels | |
| | **Visceral fat level classification:** 0 (Normal) / + (High) / ++ (Very High) 3 levels<br>* The age range for the Body Fat percentage, Body fat percentage classification, Skeletal Muscle percentage, Skeletal Muscle percentage classification, Resting Metabolism is 6 to 80 years old.<br>* The age range for the Visceral Fat level, Visceral Fat level classification and Body Age is 18 to 80 years old. | |
| **Transmission Protocol** | **Bluetooth®** low energy technology | |
| **Wireless communication** | **Frequency range:** | 2.4 GHz (2400 - 2483.5 MHz) |
| | **Modulation:** | GFSK |
| | **Effective radiated power:** | <20 dBm |
| **Setting Items*** | The following information can be stored for up to 4 persons. | |
| | **Measurement unit** | kg&cm |
| | **Birth date** | January 1st, 1900 to December 31st, 2045 |
| | **Gender** | Male / Female |
| | **Height** | 100.0 to 199.5 cm with an increment of 0.5 cm |
| | * When the height of a person is less than 100.0 cm or more than 199.5 cm, BMI and body composition measurement results are for reference. | |
| **Weight Accuracy** | 2.0 kg to 40.0 kg: ± 0.4 kg | |
| | 40.0 kg to 150.0 kg: ± 1% | |
| **Accuracy (S.E.E.)** | **Body Fat percentage:** | 3% |
| | **Skeletal Muscle percentage:** | 3.5% |
| | **Visceral Fat Level:** | 2 levels |
| **Durable Period** | 5 years | |
| **IP Classification** | IP21 | |
| **Power Supply** | 4 AAA alkaline batteries (LR03) | |

**Fig. 2: Technical specifications of Omron HBF-222T**

The overall prevalence of sarcopenia in the study population was found to be 3.3% (n=05) across cases and controls. The prevalence was found to be 4.0% (n=03) among the diabetic subset (cases) and 2.67% (n=02) in the non-diabetic subset (controls), as per BIA. In a study conducted in the Dakshin Kannada district of Karnataka, the overall prevalence of sarcopenia was found to be 14.2% in the elderly population [6]. This study, however, focused mainly on the elderly population and did not include other age groups.




| Correlation of diabetes with sarcopenia | | | |
|---|---|---|---|
| | **Value** | **Df** | **p-value** |
| Pearson Chi-square | 0.207 | 1 | 0.649 |

In a study conducted by Bahat *et al*. in community-dwelling older adults in Turkey [7], it was shown that the addition of calf-circumference to the SARC-F questionnaire improved the diagnostic accuracy and specificity. The SARC-CalF questionnaire predicted sarcopenia in 19 individuals (12.67% of the study population) with a sensitivity of 40% and a specificity of 100% when used at the recommended cutoff of ≥11. Thus, we chose the SARC-CalF questionnaire to screen for sarcopenia in our study.

| SARC-calf score in Sarcopenia | | |
|---|---|---|
| **Positive if greater than or equal to** | **Sensitivity** | **1 - Specificity** |
| 1 | 1.000 | 0.594 |
| 2 | 1.000 | 0.547 |
| 3 | 1.000 | 0.461 |
| 4 | 1.000 | 0.438 |

| | | |
|---|---|---|
| 5 | 1.000 | 0.406 |
| 6 | 1.000 | 0.398 |
| 7 | 1.000 | 0.391 |
| 8 | 1.000 | 0.375 |
| 9 | 1.000 | 0.367 |
| 11 | 0.400 | 0.000 |
| 13 | 0.400 | 0.000 |
| 14 | 0.400 | 0.000 |
| 15 | 0.200 | 0.000 |
| 17 | 0.000 | 0.000 |
| 19 | 0.000 | 0.000 |

In a meta-analysis conducted by Chung *et al.* among community-dwelling Asian geriatric population, the prevalence of sarcopenia was 15.9% in diabetics and 10.8% in non-diabetics. The diabetic population had a significantly higher risk of sarcopenia compared to non-diabetics (p=0.009) [8].

In another case–control study conducted by Pechmann *et al.*, cases were shown to have a higher incidence of sarcopenia than controls [9].

In our study, three cases (diabetics) were found to be sarcopenic, while two controls (non-diabetics) were found to have sarcopenia. Diabetes did not show a significant association with sarcopenia (p=0.649). Although our study included age- and sex-matched cases and controls, various other confounding factors such as body built and socioeconomic status were not matched, which may have affected the results.

| Sarcopenia | Non-diabetic | Diabetic | Total |
|---|---|---|---|
| No | 73 | 72 | 145 |
| Yes | 02 | 03 | 05 |
| Total | 75 | 75 | 150 |

| Correlation of diabetes with sarcopenia | | | |
|---|---|---|---|
| | Value | Df | p-value |
| Pearson Chi-square | 0.207 | 1 | 0.649 |

Among the cases, the mean HbA1c was found to be 10.1120%. In a meta-analysis conducted by Qiao *et al.*, the risk of sarcopenia was found to be significantly correlated with higher HbA1c levels. Our study failed to find a significant correlation of sarcopenia with HbA1c levels (p=0.498).

| Correlation of HbA1c with sarcopenia | | |
|---|---|---|
| | Value | p-value |
| Pearson's R | −0.108 | 0.358 |

| Relationship of HBA1c with SARC-CalF questionnaire | | | |
|---|---|---|---|
| | Value | Degrees of freedom | p-value |
| Pearson Chi-Square | 48.214 | 50 | 0.545 |

In a study conducted by Bai *et al.*, sarcopenia was shown to be significantly associated with hypertension [10]. Our study enrolled 36 hypertensives of which and 5.56% (n=02) were found to have sarcopenia. Our study found no significant association of hypertension with sarcopenia (p=0.394).

| | Non-hypertensives | Hypertensives | Total |
|---|---|---|---|
| | Number of cases | Number of cases | |
| Sarcopenia | | | |
| No | 111 | 34 | 145 |
| Yes | 03 | 02 | 05 |
| Total | 114 | 36 | 150 |


**Fig. 3: Omron HBF-222T**

| Correlation of hypertension with sarcopenia | | | |
|---|---|---|---|
| | Value | Degrees of freedom | p-value |
| Pearson Chi-square | 0.726 | 1 | 0.394 |

## CONCLUSION

## AUTHORS CONTRIBUTION

Dr. Savita Kumari had conceptualized, planned, supervised, collection of data and interpretation, analyzed research, and edited the write up of research article. Dr. Yatharth Bansal had contributed to planning, collection of data, analysis of research, write up of research, and editing of the research article.

## CONFLICTS OF INTEREST

Nil.

## FUNDING OF RESEARCH

Nil.

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