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Research Article

Sarcopenia and It's Determinants Among Urban Indian T2DM and Healthy Subjects : An Exploratory Study

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Abstract

Introduction: Sarcopenia affects all populations across the globe. A multicontinental study done across 3 continents reported a prevalence of 15.2%. Indian prevalence of sarcopenia has been reported at 14.2% in older adults and 3.2% in younger adults. India has been termed the diabetes capital of the world with more than 80 million cases. We aim to study the prevalence of sarcopenia in younger urban Indian adults both healthy and those with diabetes.

Methods: Healthy controls (n=40; females n=11, males n=29) and type 2 diabetes subjects (T2DM) (n=61; females n=6, males n=55) aged 30-60 years were recruited from health check department of a multispecialty hospital, Bangalore. Subjects with duration of diabetes less than 15 years (average BMI 25.54 Kg/m2) without co-morbidities were included. Subjects underwent full body dual energy x-ray absorptiometry scan (DEXA) and forearm muscle handgrip strength (HGS) at the same center. Sarcopenia was identified using skeletal muscle mass index (SMI) calculated as appendicular skeletal muscle mass/height^2 (Kg/m^2) <7 Kg/m^2 for men and <5.4 Kg/m^2 for women.

Results: The overall prevalence of sarcopenia was much higher than earlier reported values at 36.6%. Men reported a higher prevalence of 39.3% whereas women reported 23.5%. Low HGS was seen in both diabetic and healthy subjects. Contingency analysis showed no correlation between presence of diabetes and sarcopenia (low SMI : controls 30.0% and diabetics 41.0% ; p-value 0.263). No correlation was found between sarcopenia and gender. Presence of sarcopenia significantly associated with BMI. Lower SMI affected the apparently healthy younger Indian adults irrespective of their glycemic status.

Conclusion: Diabetes is known to cause slow reduction in muscle mass. However, in this study the lack of association between diabetes and sarcopenia points at a bigger problem. Prevalence of sarcopenia among Indians is under-reported which could be the precursor for development of diabetes warranting the need for more studies. Ongoing intervention studies focusing on protein supplementation and exercise could help in designing diabetes treatment targeted at prevention of muscle loss.

Keywords: Diabetes; Sarcopenia; Body Mass Index; Body Fat; Muscle

Abbreviations

T2DM: Type 2 Diabetes; BMI: Body Mass Index; SMI: Skeletal Muscle Mass Index; HGS: Handgrip Strength; DEXA: Dual Energy Xray Absorptiometry

Introduction

Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with the risk of adverse outcomes, such as physical disability, poor quality of life and death [1].

The diagnosis of Sarcopenia is the presence of both low muscle mass and low muscle function (strength or performance) (EWGSOP) [2]. A collaborative research on ageing, which included 18,363 people from Finland, Poland, Spain, China, India, Mexico, Russia, and South Africa reported the prevalence of Sarcopenia as 15.2% [3]. Studies done in India considering elderly population have reported a prevalence of 17.5%, 14.2% and 3.2% [3-5]. Asian Indians are known to typically have lower lean mass (organ and muscle mass) relative to stature and total body mass when compared to Europeans [6]. Lower Muscle mass has been associated with an increased risk of type two diabetes in middle age and older Asian adults [7]. The 'take-off point' for increased prevalence of T2DM among Asian Indian people is 25-34 years old, clearly a decade or two earlier than in western populations, according to the ICMR-INDIAB study [8]. The thin fat Indian or Asian Indian phenotype Hypothesis states that Asian Indians have higher waist circumference, body fat and visceral fat at any body mass index and age as compared to Europeans which increases their risk of insulin resistance, metabolic syndrome, diabetes, lipidaemia, and cardiovascular disease [9].

About 463 million people were diagnosed with diabetes worldwide in 2019, and that number is expected to rise to 700 million by 2045 [10]. As of 2019, India is home to the second highest number of adults with diabetes (77 million) [11]. The sharp rise in diabetes cases could be due to the adaption of an unhealthy lifestyle, insufficient physical activity and unhealthy diet [12].

The aim of this study was to assess the prevalence and determinant factors of sarcopenia among individuals with diabetes and healthy controls. This would facilitate an understanding of modifiable factors such as protein sufficiency, diet and exercise which can be incorporated to reduce the dual burden of sarcopenia and diabetes.

Materials and Methods

Study participants (healthy controls and T2DM subjects) were enrolled from the health check department of a multispecialty hospital by doctor reference and opportunistic method.

Inclusion criteria were as follows: Adults with Type 2 Diabetes (diagnosis by American Diabetic Association criteria), Duration of Diabetes > 6 months of diagnosis to 15 years, Diabetic without complications, Age: 30-60 years, Non-obese BMI: 18.5- 29.9 kg/m^2 (World Health Organization criteria) and both males and females.

Exclusion criteria were as follows: History of chronic diseases (Tuberculosis, cancer, chronic renal failure, ischemic heart disease), alcohol intake greater than 2 STD per day and any form of anemia.

Study was approved by the Institutional Ethics Committee, University Of Mysore. After screening to meet inclusion criteria and obtaining informed consent, subjects (healthy controls n=40; females n=11, males n=29 and T2DM subjects n=61; females n=6, males n=55) were enrolled. Biochemical parameters included fasting blood glucose, HbA1c and lipid profile (LDL, HDL, triglycerides and total cholesterol).

Subjects underwent dual-energy X-ray absorptiometry (DEXA) scan. Whole body and regional body composition was estimated using DEXA (Hologic Horizon Wi S/N 305996M)). The mass of lean soft tissue, fat, and bone mineral for both the whole body and specific regions was obtained. DEXA was used to provide measures of total fat, visceral fat, android fat, gynoid fat, trunk fat and appendicular lean mass. Appendicular lean mass equivalent to the sum of lean soft tissue in both the right and left arms and legs was obtained. Appendages were isolated from the trunk and head by using DXA regional computer-generated default lines, with manual adjustment, on the anterior view planogram. Sarcopenia was identified using skeletal muscle mass index (SMI) calculated as appendicular skeletal muscle mass/height^2 (Kg/m^2) <7 Kg/m^2 for men and <5.4 Kg/m^2 for women as classified by the Asian Working Group for Sarcopenia 2019 [13,14]. Muscle strength was assessed using handgrip dynamometer (INCO Ambala, India). Subjects were demonstrated how to use the dynamometer. Each test involved squeezing the dynamometer at maximum strength for 3 seconds with straight elbow in the non-dominant hand repeated thrice.

Statistical Analysis

The collected data was entered in the Microsoft Excel 2016 and analyzed with IBM SPSS Statistics for Windows, Version 29.0.(Armonk, NY: IBM Corp). For the descriptive statistics frequency analysis, percentage analysis were used for categorical variables

and the mean & S.D were used for continuous variables. To find the significant difference between the bivariate samples in Independent groups the Independent sample t-test was used. To assess the relationship between the variables the Pearson's correlation was used. To find the significance in qualitative categorical data as the expected cell frequency is less than 5 in 2 × 2 tables then the Fisher's Exact was used. In all the above statistical tools the probability value 0.05 is considered as significant level.

Results and Discussion

Primary aim of this study was estimating the prevalence of sarcopenia in younger Indian population and assessing the factors associated with it. Assessment of sarcopenia in a younger Indian population was done with average age of 45.95 ± 7.7 years for diabetes group and 41.73 ± 7.3 years for the healthy controls. Most studies assessing sarcopenia include population older than 60 years [15,16], however Asian Indians are more prone to sarcopenia and its related disorders at a young age [17,18].

The overall prevalence of sarcopenia was found to be 36.6% which is much higher than earlier reported values of 15.2%, 10% and 14.2% [3,17,19]. The prevalence was higher in men (39.3%) as compared to women (23.5%). A similar pattern was observed in the study done in Western India which also used DEXA for the sarcopenia assessment. However, they reported a lower rate of prevalence with men at 18.3% and women at 12% [17].

DEXA generated fat profile healthy controls and diabetes subjects was categorized into android fat (44.3 ± 5.6, 42.3 ± 6), gynoid fat (39.9 ± 6.3, 36.1 ± 6.2; p-value 0.003) and estimated visceral fat mass (681.6 ± 192, 774.4 ± 216.5; p-value 0.03). Visceral fat mass for T2DM group was significantly higher than controls and higher than normative value of 710 g for this age [20]. Higher visceral fat has been associated with inflammation, disglycemia, adverse cardiometabolic profile, insulin resistance and an "obese" phenotype regardless of adiposity status [21].

The biochemical profile indicated diabetes subjects when compared with healthy controls had significantly higher fasting blood glucose (181.5 ± 65.9, 89.6 ± 9.9; p-value 0.00) and glycated haemoglobin (5.3 ± 0.5, 9.2 ± 2.1; p-value 0.00). Low muscle strength was seen in both diabetic and healthy subjects (14.2 ± 5, 16.0 ± 6.1). High prevalence of sarcopenia (30%) and low grip strength in the apparently healthy population is a serious concern. Lower SMI affects the apparently healthy younger Indian adults irrespective of their glycemic status.

The chi square test results indicated association between sarcopenia and different variables. The primary finding of importance from this analysis is the lack of significant association between presence of T2DM and sarcopenia (p=value 0.263). The young Indian subjects irrespective of glycemic status (both healthy controls and T2DM subjects) were sarcopenic (36.6%). This points at the bidirectional relationship between sarcopenia and T2DM. The existence of adiposity, low muscle mass and function are associated with higher incidence of T2DM [22,23]. On the other hand, the increased oxidative stress, advanced glycation end products (AGEs) and insulin resistance in T2DM may affect normal cellular functioning which leads to muscle mass loss, strength and function [24]. Presence of sarcopenia and gender had no association with p-value of 0.277.

BMI and sarcopenia shared a strong association (p-value 0.0005). BMI of the enrolled non-obese subjects healthy controls and T2DM subjects was 26.2 ± 2.5 and 25.5 ± 2.9 respectively. This finding is consistent with cross sectional data from the English Longitudinal Study of Ageing (n=5783) highlighting the risk of prob-

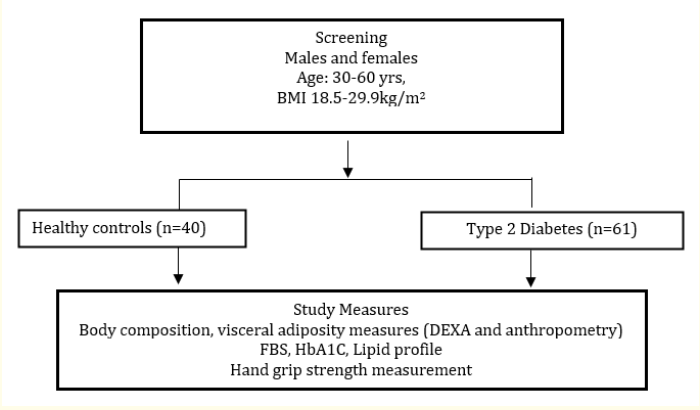

Figure 1: Flowchart indicating the study design and subject study measures.

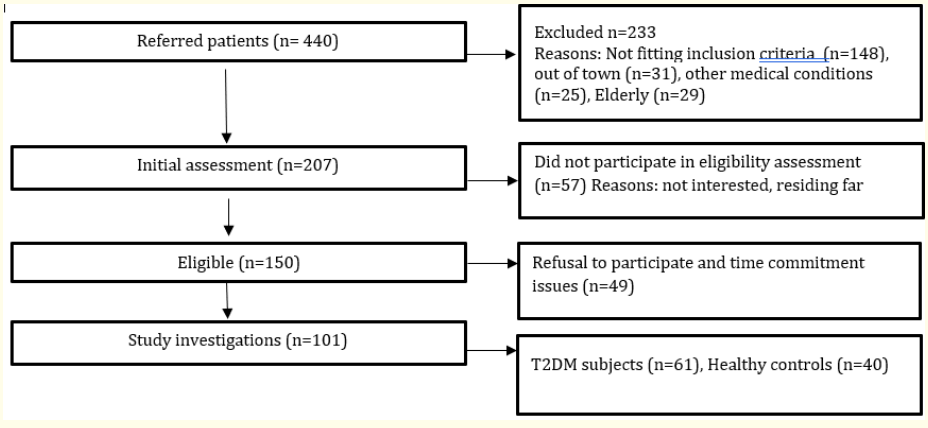

Figure 2: Consort diagram indicating subject enrolment stages with reasons for non-participation.

Characteristic	Healthy controls (n = 40)	T2DM group (n = 61)	p-value
Age (yrs)	41.7 ± 7.3	45.9 ± 7.6*	0.007
BMI kg/m^2	26.2 ± 2.5	25.5 ± 2.9	0.278
Waist circumference (cm)	87.6 ± 7.1	87.5 ± 11.7	0.976
Hip circumference (cm)	99.8 ± 7.2	98.8 ± 13.5	0.707
Bone mineral density BMD (g/cm^2)	1.1 ± 0.08	1.1 ± 0.09	0.610
Body fat percent (%)	37.9 ± 5.5	35.1 ± 5.5*	0.017
Visceral fat mass (g)	681.6 ± 192.1	774.4 ± 216.5*	0.030
SMI (kg/m^2)	6.9 ± 0.9	6.9 ± 0.8	0.699
Forearm handgrip strength (Kg)	16 ± 6	14.1 ± 5	0.209

Table 1: General characteristics of study population: Anthropometry and DEXA outcomes.

p- value ** Highly Statistical Significant at $p < 0.01$

p-value * Statistical Significant at $0.01 \leq p \leq 0.050$

Test	Healthy controls (n = 40)	T2DM group (n = 61)	p-value
Fasting glucose (g/dL)	89.6 ± 9.9	181.5 ± 65.9**	0.0005
Glycated hemoglobin (%)	5.3 ± 0.5	9.2 ± 2.1**	0.0005
Total cholesterol (mg/dL)	200 ± 34.3	173.2 ± 50.2**	0.008
Triglycerides (mg/dL)	154.3 ± 100.6	167.6 ± 94	0.560
LDL (mg/dL)	147.7 ± 32.3	122.5 ± 40.8**	0.003
HDL (mg/dL)	47.9 ± 14.7	42.7 ± 9.2*	0.049

Table 2: Biochemical outcomes of study population.

p- value ** Highly Statistical Significant at $p < 0.01$

p-value * Statistical Significant at $0.01 \leq p \leq 0.050$

	Healthy controls (n = 40)	T2DM group (n = 61)
Sarcopenia present (%)	30	41
Interaction: presence of diabetes and sarcopenia (p-value)	0.263	

Table 3: Sarcopenia and its determinants compared in study groups.

Table 3.1: Presence of diabetes and Sarcopenia.

Pearson Chi square test.

	Men (n = 84)	Women (n = 17)
Sarcopenia present (%)	39.3	23.5
Interaction: Gender and sarcopenia (p-value)	0.277	

Table 3.2: Gender and Sarcopenia.

Fisher's Exact Test

	Normal BMI (n = 37)	Overweight (n = 64)
Sarcopenia present (%)	64.9	20.3
Interaction: BMI and sarcopenia (p-value)	0.00*	

Table 3.3: BMI and Sarcopenia Pearson.

Chi square test.

able sarcopenia and BMI [25].

Conclusion

The lack of association between the presence of T2DM and sarcopenia indicates that Indians at a young age are at an increased risk for musculoskeletal and metabolic diseases. Sarcopenia and T2DM have a bidirectional relationship, they increase the risk of each other and lead to functional decline and disability. Various factors including mechanization of labor, migration from rural to urban areas, sedentary lifestyle, protein deficiency and lack of exercise contribute to this problem.

High prevalence of sarcopenia needs more attention and is a bigger hidden problem of the Indian society. There is a need for public awareness and education for long term improvement of health and reduction of diabetes load. Intervention studies focusing on root causes of low muscle mass and strength including both weight training exercises and dietary changes with protein sufficiency will be helpful.

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Conflict of Interest

Bibliography

1. Delmonico Michael J., *et al.* "Alternative Definitions of Sarcopenia, Lower Extremity Performance, and Functional Impairment with Aging in Older Men and Women". *Journal of the American Geriatrics Society* 55.5 (2007): 769-774.

2. Cruz-Jentoft Alfonso J., *et al.* "Sarcopenia: Revised European Consensus on Definition and Diagnosis". *Age and Ageing* 48.1 (2019): 16-31.

3. Tyrovolas Stefanos., *et al.* "Factors Associated with Skeletal Muscle Mass, Sarcopenia, and Sarcopenic Obesity in Older Adults: A Multi-Continent Study". *Journal of Cachexia, Sarcopenia and Muscle* 7.3 (2016): 312-321.

4. Shaikh N., *et al.* "Prevalence of Sarcopenia in an Elderly Population in Rural South India: A Cross-Sectional Study". *F1000Research* 9 (2020): 175.

5. Pal R., *et al.* "The Prevalence of Sarcopenic Obesity in Community-Dwelling Healthy Indian Adults—The Sarcopenic Obesity-Chandigarh Urban Bone Epidemiological Study (SO-CUBES)". *Osteoporosis and Sarcopenia* 7 (2021): 24-29.

6. Pomeroy Emma., *et al.* "Ancient Origins of Low Lean Mass among South Asians and Implications for Modern Type 2 Diabetes Susceptibility". *Scientific Reports* 9 (2019): 10515.

7. Son Jae Woong., *et al.* "Low Muscle Mass and Risk of Type 2 Diabetes in Middle-Aged and Older Adults: Findings from the KoGES". *Diabetologia* 60 (2017): 865-872.

8. Anjana Ranjit Mohan., *et al.* "The Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) Study: Methodological Details". *Journal of Diabetes Science and Technology* 5.4 (2011): 906-914.

9. Deepa R., *et al.* "Abdominal Obesity, Visceral Fat, and Type 2 Diabetes—'Asian Indian Phenotype'". *Type 2 Diabetes in South Asians: Epidemiology, Risk Factors and Prevention*, edited by V. Mohan and G. H. Rao, Jaypee Medical Publishers (2006): 138-152.

10. Saeedi Pouya., *et al.* "Global and Regional Diabetes Prevalence Estimates for 2019 and Projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th Edition". *Diabetes Research and Clinical Practice* 157 (2019): 107843.

11. Pradeepa Rajendra and Viswanathan Mohan. "Epidemiology of Type 2 Diabetes in India". *Indian Journal of Ophthalmology* 69.11 (2021): 2932-2938.

12. Pradeepa R and V Mohan. "Prevalence of Type 2 Diabetes and Its Complications in India and Economic Costs to the Nation". *European Journal of Clinical Nutrition* 71 (2017): 816-824.

13. Baumgartner Richard N., *et al.* "Epidemiology of Sarcopenia among the Elderly in New Mexico". *American Journal of Epidemiology* 147.8 (1998): 755-763.

14. Chen Liang-Kung., *et al.* "Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment". *Journal of the American Medical Directors Association* 21.3 (2020): 300-307.e2.

15. Rolland Yves., *et al.* "Sarcopenia: Its Assessment, Etiology, Pathogenesis, Consequences and Future Perspectives". *The Journal of Nutrition, Health and Aging* 12 (2008): 433-450.

16. Hwang Jongseok and Soonjee Park. "Gender-Specific Risk Factors and Prevalence for Sarcopenia among Community-Dwelling Young-Old Adults". *International Journal of Environmental Research and Public Health* 19.12 (2022): 7232.

17. Bhat Gauri., *et al.* "Prevalence and Factors Associated with Sarcopenia among Urban and Rural Indian Adults in Middle Age: A Cross-Sectional Study from Western India". *PLOS Global Public Health* 4.10 (2024): e0003553.

18. Zengin A., *et al.* "Prevalence of Sarcopenia and Relationships between Muscle and Bone in Indian Men and Women". *Calcified Tissue International* 109 (2021): 423-433.

19. Shaikh N., *et al.* "Prevalence of Sarcopenia in an Elderly Population in Rural South India: A Cross-Sectional Study". *F1000Research* 9 (2020): 175.

20. Hirsch Katie R., *et al.* "Visceral Adipose Tissue Normative Values in Adults from the United States Using GE Lunar iDXA". *Clinical Physiology and Functional Imaging* 39.6 (2019): 407-414.

21. Bays HE. "Adiposopathy: Is 'Sick Fat' a Cardiovascular Disease?" *Journal of the American College of Cardiology* 57.25 (2011): 2461-2473.

22. Hong Seung-Joo., *et al.* "Relative Muscle Mass and the Risk of Incident Type 2 Diabetes: A Cohort Study". *PLOS ONE* 12.11 (2017): e0188650.

23. Wang Y., *et al.* "Comparison of Abdominal Adiposity and Overall Obesity in Predicting Risk of Type 2 Diabetes among Men". *American Journal of Clinical Nutrition* 81.3 (2005): 555-563.

24. Mesinovic Jakub., *et al.* "Sarcopenia and Type 2 Diabetes Mellitus: A Bidirectional Relationship". *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* 12 (2019): 1057-1072.

25. Curtis Molly., *et al.* "Associations between Body Mass Index and Probable Sarcopenia in Community-Dwelling Older Adults". *Nutrients* 15.6 (2023): 1505.