ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Research Article

Body Composition Distribution in Type 2 Diabetic Patients at The Hospital De San José

José León[1,2,4], Jonny Garzón[1,4], William Rojas[1,3], Angela Marquez[4] and Orlando Angulo[4,5,6]*

[1]*Professor at the Department of Physical Activity and Sports Medicine, "Fundación Universitaria de Ciencias de la Salud", Bogotá, Colombia*

[2]*Head of Sports Medicine Department at the Hospital de San José, Bogotá, Colombia*

[3]*Head of Endocrinology Department at the Hospital de San José, Bogotá, Colombia*

[4]*Sports Medicine Physician, Bogotá, Colombia*

[5]*Sports Medicine and Sports Nutrition Department, Renacerá IPS Villavicencio, Colombia*

[6]*Ad Honorem Professor at FUCS, "Fundación Universitaria de Ciencias de la Salud", Bogotá, Colombia*

***Corresponding Author:** Orlando Angulo, Sports Medicine Physician, Bogotá, Colombia.

Received: June 12, 2020; **Published:** July 29, 2020

Abstract

Objectives: To determine the distribution of the percentage of body fat and the muscle percentage of patients diagnosed with Diabetes mellitus type 2.

Method: It is a cross-sectional study. Included subjects of external consultation of Endocrinology with a diagnosis of diabetes mellitus type 2. Anthropometric data measured by tetrapolar bioimpedance, 6 meters speed test and handgrip dynamometry.

Results: The prevalence body fat was 40.5% (32.2 - 43.0) females and 32.3% (22.4 - 38.60) males and muscle mass females 26.5%(22.0 - 29.5) and males 29.5%(27.6 - 35.1). Also, it was found Sarcopenia prevalence in 32% according to the European consensus of sarcopenia of 2010 and 10% with the new cut-off points of the 2018 consensus, we also highlight that only the 12% are in BMI index below 25 kg/mt^2.

Conclusion: The majority of the population of patients diagnosed with DM 2 are overweight and obese diagnosed not only by weight but according to their percentage of fat measured by impedance, a risk factor not taken into account or treated, which leads to higher cardiovascular risk in addition to leading to the development of sarcopenia and dynapenia, which we consider is a modifiable factor through monitored and supervised regular physical activity that deals with direct benefits on the Diabetes Mellitus management and prognostic.

Keywords: *Composition; Corporal; Fat Free Mass; Lean Mass; Diabetes Mellitus Type 2; Sarcopenia; Obesity*

Introduction

The population with Diabetes Mellitus has been exponential increasing, the International Diabetes Federation (IDF) has reported that around 425 million people worldwide and have described that 8.8% of adults aged 20 to 79 have diabetes. About 79% live in low- and middle-income countries and the number of people with diabetes reaches 451 million if the age is extended to the range of 18 to 99 years. If these trends continue, by 2045, 693 million people aged 18 to 99, or 629 million people aged 20 to 79, will have diabetes [25].

Recently the term paradoxical obesity has been included, which refers to an inversely proportional relationship of the Body Mass Index (BMI) to chronic diseases; for this reason it has become vitally important to determine body composition, among which fat mass has been studied in patients with coronary heart disease, resulting in a significant decrease in mortality by controlling this risk factor in 3 years [1,2].

Data on body composition is essential and crucial when performing an optimal physical activity and exercise prescription, being more objective and focused when it comes to combating complications of chronic diseases, such as sarcopenia, HIV-AIDS, obesity and others that occur or may take place in diabetic patients, which require an individualized exercise prescription [4].

Diabetes causes changes in body composition due to genetic, pharmacological, physiological, behavioral and dietary factors, among others. Body composition can be measured by different methods such as adipometry, bioelectrical impedance, dual energy x-ray absorptiometry and plethysmography with instruments such as "BODPOD®" [9,10]; however, factors that alter this measurement should be considered, such as variations in height, age, weight, nutritional status, hydration, among others [2,4,27].

Sarcopenia as a 21st century pathology is defined as a progressive and widespread skeletal muscle disorder that is associated with a higher likelihood of adverse outcomes including falls, fractures, physical disability and mortality, specifically sarcopenia is likely when low muscle strength is detected and diagnosis is confirmed by the presence of a low muscle amount or quality associated with low muscle strength, the latter is known as dynapenia that is defined as loss of age-related muscle strength, not caused by muscle or neurological diseases [31], when we have results of a low amount or muscle quality and low physical performance, sarcopenia is considered severe [26]. Diagnosis of this pathology according to the first consensus made in 2010 is made when you have loss of muscle mass with a skeletal muscle mass index of less than 10.76 kg/m^2 in men and 6.76 kg/m^2 in women, plus one of the following parameters: decreased physical performance < 0.8 m/s in 6 meters speed walking test (gait speed) or decrease in handgrip force: men 30 kg, women 20 kg [21]; nonetheless, the new cut-off points according to the 2018 consensus are: Appendicular muscle mass index (AMI) less than 7 kg/m^2 in men and less than 6 kg/m^2 in women or muscle weight < 20 kg in men and < 15 kg in women, gait speed - 0.8 m/s and pressure force less than 27 kg in men and less than 16 kg in women [26]. Depending on the body fat percentage, those with percentages above 25% in males and 33% in women are defined as obese subjects. Values between 21 and 25% in males and between 31 and 33% in women are considered borderline. Normal values are in the order of 12 to 20% in males and 20 to 30% in women [30].

The reported national literature on body composition and diabetes is scarce, as only 2 articles were found from which, none determines body composition with impedanciometry which is important since this is considered a validated, reproducible, simple and economical method to determine body composition, in addition, it is not dependent on the observer. The first study was conducted in 2007 aimed to evaluate leptin concentrations in a group of Colombian schoolchildren and their relationship to age, sex, BMI, tricipital fold and blood lipids [22] and the second aimed to establish the relationship between the prevalence of high blood pressure and DM2 with waist; thus initiating prevention actions with perimeter alterations [23].

Aim of the Study

The aim of this study is to determine the distribution of the percentage of fat mass and the percentage of muscle mass of patients with DM2 who consult the endocrinology service at the Hospital de San José over a period of 6 months.

Methods

Sample

A total of 150 patients diagnosed with DM2 were included who attended the endocrinology service of the Hospital San José and the disease is controlled. Patients who for some reason were unable to perform or could not maintain standing position were excluded; patients who were informed during the consultation of their diagnosis of diabetes, regardless of the means by which the diagnosis is made and that they have not started treatment, patients who voluntarily after knowing the purpose and benefit of participating in the study did not wish to do so, these were excluded as well.

Design

This was a cross-sectional study conducted at the Hospital de San José, Bogotá. The collection was done for 6 months. All measurements were performed during the medical consultation, applying a survey. To determine the size, patients were placed so that the head, shoulders, hips and heels together should be glued to the wall under the line of the height meter tape. The arms should hang freely and naturally on the sides of the body. Front view at a fixed point, with a slat the stop is placed on the head with a slight pressure to flatten the hair and is given reading the measurement, weight and body composition (percentage of fat mass and fat-free mass), were estimated by impedanciometry with the impedanciometer OMRON HBF - 510w® (OMRON Matsukasa Co. LTD, Japan), it has been validated against densitometry [24] and skin folds [25], which measures the impedance of feet to hands throughout the body. Measurements were made following the manufacturer's recommendations, obtaining from both BMI and skeletal muscle mass index (SMI), placing the patient standing on the scale asking him to stand straight and raise the right arms at an angle of 45º to take the upper limbs polar electrodes, to measure the force, it was used Baseline dynamometer®. Hydraulic Hand Dynamometer, standing patient raising the measuring arm up to 90 or with full extension of the elbow which was performed in both upper limbs. All instruments used for measurements were calibrated at the start of the study to reduce possible biases.

Statistical analysis

The data was recorded in Excel. The analysis was performed in STATA 13. Qualitative variables were analyzed by absolute and relative frequencies; and quantitative variables were summarized with central trend and dispersion measures (mean and standard or median deviations and interquartile ranges), depending on their distribution.

This project was approved by the Ethics Committee on Human and the Research Division at Fundacion Universitaria de ciencias de la Salud (FUCS). No clinical interventions were performed in patients, nor invasive measurements, no actions were committed or altered the health status of patients who collaborated with this study, for this reason the committee approved not to use written informed consent by requiring it only verbally. This project is also under the protection of the "HELSINKI Declaration of the World Medical Association - Ethical Principles for Medical Research in Humans", we will solicitously ensure the health of our patients (general principle 3).

Results

The number of patients who attended during the six months were 197, of which 33 patients did not wish to participate in the study and 14 were excluded, for a total of 150 patients included in the study.

Demographic characteristics are in table 1. 60.7% of the target population was over 61 years of age. The highest proportion in time of evolution of diabetes was found between 5 and 10 years in men (41%). 88% of the total participating population was in ranges of overweight and obesity according to the BMI tables of the World Health Organization (WHO).

The average fatty tissue in women was 40.5 (IQR 32.2 - 43.0), and in men 32.2 (IQR 22.4 - 38.6), which leads to the diagnosis of obesity in both populations, which in both cases is much higher than the diagnosis of obesity made by body mass index (Table 1 and 2).

The average skeletal muscle mass index (SMI) for both sexes, showed that, despite the predominance of fat mass index in total body weight, adequate muscle mass is maintained, resulting in a diagnosis of sarcopenia only in the 10% of the evaluated population (Table 1).

Regarding associated pathologies, no patient with diagnosis of diabetes alone was found, the predominant comorbidity was hypertension in me 44.3% and women 58.4%, followed by hypothyroidism in women and chronic kidney disease in men (Table 1). When the study data was analyzed, it was found that there is a higher frequency of sarcopenia in men 14.8% than in women 6.7% according to the criteria of the 2018 consensus. The latter was performed extrapolating the AMI cut-off points towards SMI, as with our device we cannot measure appendicular mass.

Demographic characteristics n (%)	Female n = 89 (59.3)	Male n = 61 (40.7)	Total n = 150 (100%)
Age, years n (%)			
24 - 50	13 (14.6)	9 (14.8)	22 (14.7)
51 - 60	20 (22.5)	17 (27.9)	37 (24.7)
> 61	56 (62.9)	35 (57.4)	91 (60.7)
Disease progression DM2, years n (%)			
< 5	27 (30.3)	15 (24.6)	42 (28.0)
5 - 10	35 (39.3)	25 (41.0)	60 (40.0)
> 10	27 (30.3)	21 (34.4)	48 (32.0)
Height - (IQR)	1.53 (1.51 - 1.60)	1.62 (1.53 - 1.69)	1.56 (1.51 - 1.64)
Weight - (IQR)	70 (61.30 - 79.00)	73.5 (61.5 - 84.5)	71.8 (61.3 - 82.00)
BMI n (%) Kg/mts ^{2}			
≤ 25	4 (4.5)	14 (23.0)	18 (12.0)
25.1 - 30	47 (52.8)	32 (52.5)	79 (52.7)
≥ 30.1	38 (42.7)	15 (24.6)	53 (35.3)
Body composition - (IQR)			
% Fat mass	40.5 (32.2 - 43.0)	32.2 (22.4 - 38.60)	35.3 (28.7 - 41.5)
% Muscle mass	26.5 (22.0 - 29.5)	29.5 (27.6 - 35.1)	27.7 (25.2 - 32.5)
Weight muscle Mass KG - (IQR)	19 (15.45 - 22.1)	22,7 (20.36 - 25.35)	20.7 (16.8 - 23.89)
IMME - (IQR)	7.79 (7.05 - 9.30)	8.39 (7.67 - 9.49)	8.03 (7.18 - 9.26)
Associated Diseases n (%)			
Arterial hypertension	52 (58.4)	27 (44.3)	79 (52.7)
Chronic kidney disease	27 (30.3)	14 (23.0)	41 (27.3)
hypothyroidism	31 (34.8)	8 (13.1)	39 (26.0)
Others	11 (12.4)	20 (32.8)	31 (20.7)
Sarcopenia frequency by Consensus 2010 - 2018			
Sarcopenia 2010	14 (15.7)	34 (55.7)	48 (32.0)
Sarcopenia 2018	6 (6.7)	9 (14.8)	15 (10.0)

Table 1: *Demographic characteristics.*

DM2: Diabetes Mellitus Type 2, IQR: Interquartile Range; BMI: Body Mass Index;

SMI: Skeletal Muscle Mass Index; AMI: Appendicular Muscle Index.

Body composition, according to sex and age groups, shows an average of greater muscle mass percentage in the group of 51 to 60 years of age of the male sex 34.5% (IQR 28.0% - 36.7%), with an approximate loss of muscle mass in the group of over 61 years in 4.7%, while the average percentage of greater muscle mass in women was found in the group of 24 to 50 years 29.5% (IQR 27.0% - 32.5%), with an approximate loss of 3.8% regarding group over 61 years old (Table 2).

Body Composition	Age		
Male (n = 61)	24 - 50 (n = 9)	51 - 60 (n = 17)	> 61 (n = 35)
% Fat mass			
≤ 20 (Normal)	1 (11.1)	-	2 (5.7)
21 - 25 (Overweight)	5 (55.5)	6 (35.2)	7 (20.0)
> 25 (Obesity)	3 (33.3)	11 (64.7)	26 (74.2)
% Muscle mass (IQR)	27.6 (25.2 - 33.9)	34.5 (28.0 - 36.7)	29.75 (27.6 - 34.8)
Female (n = 89)	24 - 50 (n = 13)	51 - 60 (n = 20)	> 61 (n = 56)
% Fat mass			
≤ 30 (Normal)	4 (30.7)	3 (15.0)	12 (21.4)
31 - 33 (Overweight)	-	1 (5.0)	3 (5.3)
> 33 (Obesity)	9 (69.2)	16 (80.0)	41 (73.2)
% Muscle mass (IQR)	29.5 (27.0 - 32.5)	26.5 (23.2 - 28.4)	25.7 (22.0 - 28.7)

Table 2: *Body composition by sex and age.*

Discussion

Most of the population studied was off the parameters recommended regarding weight by the WHO; to classify overweight and obesity, different researchers have worked with populations that present these characteristics, regarding body composition with bioimpedanciometry, authors such as Verdich C., *et al.* and Moreno-Martín., *et al.* used tetrapolar impedance in their studies, in obese populations and young women respectively. This is a tool that has been already validated; it is not observer dependent, is inexpensive and easily reproducible [10,17-20].

As result according to reality in this terms, it was increased the distribution of fat mass in the body composition, both in men and women, a situation that puts the patient at cardiovascular risk due to obesity, which hinders an adequate control of diabetes since this leads to an increase in insulin resistance [13]. This long-term distribution of body composition also leads to functional deterioration of the patient and complications inherent in comorbidities.

Sarcopenia, defined as loss of muscle quantity or quality, has become important in the last decade, as it is directly related to aging and has been underdiagnosed, despite using accessible tools to diagnose it as described in the European Sarcopenia Consensus [26]. In the present study, DM 2 patients with sarcopenia have a prevalence of 10%, a pathological condition that can be prevented by practicing physical activity. It is to be acknowledged that the population is smaller following the criteria of the 2018 consensus compared to the prevalence with the 2010 diagnostic criteria, in which case it is 32%.

The results found are not probably the expected ones regarding fat distribution and obesity, however the study allowed us to quantify and have accurate data to make diagnoses, allowing us to create therapeutic strategies from the point of view of primary and secondary prevention impacting in the quality of life of patients.

The majority of patients with type 2 diabetes mellitus at Hospital San José are obese, a risk factor that has not been taken into account to optimize the treatment of their underlying pathology and which is a modifiable through regular, monitored and supervised physical activity. Despite the low percentage of patients diagnosed with sarcopenia, we show that 63% of the patients we evaluated have a diagnosis of dynapenia, which in the present study was evaluated with handgrip strength on dynamometry, the importance of this is that dynapenia can be a precursor for the development of sarcopenia; Muscle mass was found to be higher in the group of younger participants, which coincides with the distribution of body composition reported worldwide in the European sarcopenia consensus. The highest number of patients with obesity due to a higher percentage of fat in their body composition were in men and women over 61 years of age, with a percentage of 74.2 and 73.2%, respectively.

Another of the findings found in the present study was that the use of metformin does not intervene in body composition, contrary to what Yanovski., *et al.* mentions in his study "The effects of metformin in obese children with insulin resistance", where he mentions that treatment with this medication decreases body weight at the expense of fat percentage [18-20].

The clinical suggestion of the study according to the results found is that in DM2 patients a supervised physical activity program should be implemented, with an individualized exercise prescription as this directly influences the body composition found in each patient and therefore, the control and reduction of cardiovascular risk associated with its underlying pathology.

With the previously described findings, it can be stated that the most indicated intervention for a metabolic rehabilitation plan of this population would have as objective the physical conditioning with a high component of strength, specifically resistance exercise training as suggested by D Rojano., *et al.* which explains that the combination of a 6-week strength and aerobic physical exercise program and a hypocaloric diet in overweight menopausal women causes significant improvements in body composition and a trend towards improvement of the lipid profile, which may have an impact positively in quality of life [24].

Limitation of the Study

The main limitation of the study was not being able to determine the directionality between obesity and diabetes, despite the fact that 72% of the participants are known to have the disease for longer than 5 years. it may be assumed that the muscle mass loss leads to a decrease in glut 4 receptors; thus, the glucose supply to the muscle would be affected, setting a state of danger as the muscle is a metabolic active organ. It would have a direct relationship to be a possible cause for developing diabetes, added to the fact that the increase in Fat mass contributes to the development of insulin resistance.

Conclusion

This study concludes that the majority of the population of patients diagnosed with T2DM are Overweight and Obesity, not only due to body mass index but also according to their fat percentage measured by impedanciometry, a risk factor that is neither taken into account nor treated, which leads to increased cardiovascular risk in addition to the development of dynapenia and sarcopenia, which is considered to be a modifiable risk factor through regular, supervised and supervised physical activity that can lead to direct benefits on Diabetes Mellitus management and prognostic.

Acknowledgements

We appreciate students, interns; residents, fellows and teachers who at the time participated in clinic and data collection, as well as the service of "Physical Activity and Sports Medicine" and Endocrinology at the Fundacion Universitaria de ciencias de la salud. It is important to highlight the participation of the director in chief from the "Physical Activity and Sports Medicine" residency program, Dr. Juan Carlos Galvis Rincón, for the support and for the loan of the equipment that was used for data collection.

Conflict of Interest Statement

We have no conflict of interest.

Declaration of Financing of the Project

The entire project was financed with resources from the authors, without receiving anything from external agents. The measurement instruments were provided by the Physical Activity and Sports Medicine services at Hospital Universitario infantile de San José and Endocrinology at Hospital de San José.

Bibliography

1. Lavie CJ., *et al.* "Body composition and survival in stable coronary heart disease: impact of lean mass index and body fat in the "obesity paradox". *Journal of the American College of Cardiology* 60.15 (2012): 1374-1380.

2. Armendáriz-Anguiano AL., *et al.* "Effect of a low glycemic load on body composition and Homeostasis Model Assessment (HOMA) in overweight and obese subjects". *Nutricion Hospitalaria* 26.1 (2011): 170-175.

3. Rotella CM and Dicembrini I. "Measurement of body composition as a surrogate evaluation of energy balance in obese patients". *World Journal of Methodology* 5.1 (2015): 1-9.

4. American College of Sports Medicine Position Stand. Exercise and physical activity for older adults". *Medicine and Science in Sports and Exercise* 30.6 (1998): 992-1008.

5. Dobrosielski DA., *et al.* "Effect of exercise on blood pressure in type 2 diabetes: a randomized controlled trial". *Journal of General Internal Medicine* 27.11 (2012): 1453-1459.

6. Prior SJ., *et al.* "Increased skeletal muscle capillarization after aerobic exercise training and weight loss improves insulin sensitivity in adults with IGT". *Diabetes Care* 37.5 (2014): 1469-1475.

7. Oliveros E., *et al.* "The concept of normal weight obesity". *Progress in Cardiovascular Diseases* 56.4 (2014): 426-433.

8. Karstoft K., *et al.* "The effects of free-living interval-walking training on glycemic control, body composition, and physical fitness in type 2 diabetic patients: a randomized, controlled trial". *Diabetes Care* 36.2 (2013): 228-236.

9. Larciprete G., *et al.* "Body composition during normal pregnancy: reference ranges". *Acta Diabetologica* 40.1 (2003): S225-S232.

10. Martín Moreno V., *et al.* "Body fat and fat mass-fat free mass ratio estimated by bioelectric impedance in the nutritional evaluation of women 35-55 years of age". *Revista Española de Salud Pública* 76.6 (2002): 723-734.

11. Gernand AD., *et al.* "Maternal nutritional status in early pregnancy is associated with body water and plasma volume changes in a pregnancy cohort in rural Bangladesh". *Journal of Nutrition* 142.6 (2012): 1109-1115.

12. Turner N., *et al.* "Fatty acid metabolism, energy expenditure and insulin resistance in muscle". *Journal of Endocrinology* 220.2 (2014): T61-T79.

13. Li J., *et al.* "Duration of exercise as a key determinant of improvement in insulin sensitivity in type 2 diabetes patients". *The Tohoku Journal of Experimental Medicine* 227.4 (2012): 289-296.

14. Feng B., *et al.* "Human adipose dynamics and metabolic health". *Annals of the New York Academy of Sciences* 1281 (2013): 160-177.

15. Bacchi E., *et al.* "Metabolic effects of aerobic training and resistance training in type 2 diabetic subjects: a randomized controlled trial (the RAED2 study)". *Diabetes Care* 35.4 (2012): 676-682.

16. Carty CL., *et al.* "Low-fat dietary pattern and change in body-composition traits in the Women's Health Initiative Dietary Modification Trial". *The American Journal of Clinical Nutrition* 93.3 (2011): 516-524.

17. Verdich C., *et al.* "Changes in body composition during weight loss in obese subjects in the NUGENOB study: comparison of bioelectrical impedance vs. dual-energy X-ray absorptiometry". *Diabetes and Metabolism* 37.3 (2011): 222-229.

18. Yanovski JA., *et al.* "Effects of metformin on body weight and body composition in obese insulin-resistant children: a randomized clinical trial". *Diabetes* 60.2 (2011): 477-485.

19. Li CJ., *et al.* "Changes in liraglutide-induced body composition are related to modifications in plasma cardiac natriuretic peptides levels in obese type 2 diabetic patients". *Cardiovascular Diabetology* 13 (2014): 36.

20. Group TS. "Treatment effects on measures of body composition in the TODAY clinical trial". *Diabetes Care* 36.6 (2013): 1742-1748.

21. Lourenço RA., *et al.* "Performance of the European Working Group on Sarcopenia in Older People algorithm in screening older adults for muscle mass assessment". *Age Ageing* 44.2 (2015): 334-338.

22. Poveda E., *et al.* "Concentración sérica de leptina en población escolar de cinco departamentos del centro-oriente colombiano y su relación con parámetros antropométricos y perfil lipídico". *Biomédica* 27 (2007): 505-514.

23. Villegas A., *et al.* "Prevalencia del síndrome metabólico en El Retiro, Colombia". *Iatreia* 16 (2003): 291-297.

24. D Rojano and G Vargas. "Efectos de una dieta hipocalórica y de un programa de ejercicio físico de corta duración en el perfil lipídico y en la composición corporal de mujeres menopáusicas con sobrepeso". *Revista Andaluza de Medicina del Deporte* 7 (2014): 95-100.

25. Diabetes Atlas de la FID Octava Edición; Capitulo (2017): 43.

26. AJ Cruz-Jentoft., *et al.* "Sarcopenia: revised European consensus on definition and diagnosis". *Age and Ageing* (2018): 1-16.

27. Wells JCK. "Body composition and susceptibility to type 2 diabetes: an evolutionary perspective". *European Journal of Clinical Nutrition* 71 (2017): 881-889.

28. Gallagher D., *et al.* "Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index". *The American Journal of Clinical Nutrition* 72.3 (2000): 694-701.

29. Fatima SS., *et al.* "Body mass index or body fat! which is a better obesity scale for Pakistani population?" *JPMA: Journal of the Pakistan Medical Association* 64.11 (2014): 1225.

30. Campillo JE., *et al.* "Consenso SEEDO'2000 para la evaluación del sobrepeso y la obesidad y el establecimiento de criterios de intervención terapéutica". *Journal Medical and Clinical* 115 (2000): 587-597.

31. Sáez Moreno MÁ., *et al.* "Dinapenia y función musculo-esquelética en los pacientes mayores de 65 años". *Revista Clínica de Medicina de Familia* 11.1 (2018): 8-14.

Volume 11 Issue 8 August 2020