Original Article

Comparison of Bioelectrical Impedance Analyser (BIA) with Dual-Energy X-ray Absorptiometry (DXA) Scan in Assessing the Body Composition of Adult Individuals with Type 2 Diabetes Mellitus

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Abstract

Introduction: Assessing the body composition is important in adult patients with type 2 diabetes mellitus to prevent and achieve optimum control during treatment. Bioelectrical impedance analysis (BIA), being a more affordable method of assessing the body composition, should therefore be compared with the gold standard dual-energy X-ray absorptiometry (DXA) to look for a correlation between the two and the potential of BIA to be used widely in this population. A cross-sectional observational study was conducted on 60 patients attending the endocrinology outpatient department (OPD) of a tertiary care centre in Kolkata, India. **Methods:** Body composition was measured by both BIA and DXA. Intra-class correlation (ICC) values were calculated between the two methods for fat mass and fat-free mass for three body mass index (BMI) groups and overall. **Results:** DXA and BIA correlated well for both fat mass and fat-free mass in the entire study population and in the non-overweight non-obese group (BMI <23) and the obese group (BMI ≥25). However, the overweight group (23 ≥BMI <25) did not correlate well with the above-mentioned parameters. **Conclusion:** We suggest interchangeable use of the two methods in the non-overweight non-obese (BM I <23) and obese (BMI ≥25) BMI groups of adult subjects with type 2 diabetes mellitus. However, the low correlation for all parameters in the overweight group points towards exercising caution when taking such measurements by BIA and planning a further study with a larger cohort of such individuals to better evaluate the said correlation.

Keywords: BIA, body composition, DXA scan, type 2 diabetes mellitus

Introduction

Bioelectrical impedance analysis (BIA) was first introduced in the 1980s as a technique to estimate body composition (fat-free mass, total body water and body fat).[1] Common methods of measuring body composition include BIA and dual-energy X-ray absorptiometry (DXA). BIA is significantly more cost-effective than DXA, computed tomography (CT) or magnetic resonance imaging (MRI). It is easier to use than other technologies and is also portable.[2]

Due to the above reasons, many studies have explored the feasibility of using BIA instead of the gold standard DXA in community-based practice. An Indian study on healthy Asian Indians used two BIA equations, one for Asians and the other for Caucasians, and found that neither correlated well with DXA.[3] These findings were confirmed by González-Ruíz *et al*.[4] in their study.

While the aforementioned studies have not encouraged the widespread use of BIA to assess body composition, there are quite a few which have. A study by McLester *et al*.[5] on healthy adults in the USA has found high intra-class correlation coefficients (ICCs) for body fat percentage (BF%), Fat Mass

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(FM) and fat free mass (FFM) using $InBody_{230}$, $InBody_{720}$ and $InBody_{770}$. These BIAs are reliable and can be used instead of DXA. Similar results have been found by Donadio *et al*.[6] while working with haemodialysis patients, Fakhrawi *et al*.[7] in postmenopausal obese women and Kawakami *et al*.[8] on patients with chronic kidney disease, osteoporosis and diabetes mellitus with obesity. An interesting study published in 2018 has probed into the correlation of fat mass and fat-free mass values between BIA and DXA after having classified the population according to body mass index (BMI) classes. They have found a strong correlation and concordance for fat mass estimated by BIA and DXA irrespective of BMI. Body composition values estimated by the two methods were very close for the BMI group (16 kg/m^2 to 18.5 kg/m^2). They also found fat mass values to be very similar in the BMI group: >40 kg/m^2.[9]

Obesity is one of the causes of insulin resistance, which leads to type 2 diabetes mellitus, and the monitoring of body composition is not only important to prevent but also to regulate the control of diabetes mellitus once established.[10] Body fat percentage, unlike BMI, is independently associated with cardiovascular risk factors.[11] Therefore, it is important to measure body fat percentage to predict cardiovascular outcomes in patients with type 2 diabetes mellitus as in many of these cases BMI is normal.

Leiter *et al*.[12] have found out in their study that BIA closely relates to DXA in adults with type 1 diabetes mellitus. Beeson *et al*.[13] in Spain found general agreement between TANITA tetrapolar foot-to-foot BIA and DXA in assessing the body composition of type 2 diabetes mellitus patients. A study conducted on Indian patients with chronic pancreatitis and diabetes mellitus found that there was a good correlation between DXA and BIA in measuring total fat mass but not visceral adipose tissue.[14]

One of the limitations of BIA is that it assumes the hydration factor of the fat-free mass to be constant, and this might hinder its application in the severely obese state.[15] Body geometry and body water distribution are different in the obese state, and of which, prediction formulas developed in normal-weight subjects might underestimate body fat in the obese. Having said that, Sartorio *et al*.[16] found the estimate of total body water to be accurate in women with a wide range of BMI (19.1–48.2 kg/m^2) using BIA. We have probed into this area through our study by classifying our study population into three BMI groups and assessing the correlation between the three methods for each.

Keeping the ease of use and cost-effectiveness of BIA in mind and the need for assessment of body composition in patients with type 2 diabetes mellitus, we have ventured to design and perform a study that assesses the correlation between BIA and DXA in adult patients with type 2 diabetes mellitus, the latter being the gold standard. Although studies (as mentioned above) have been conducted on the same topic earlier, there have been no similar studies from Eastern India, and therefore, we have chosen our study population from this geographical region. Also, we have reported our findings divided into three BMI classes and have tried to explore the correlation of fat mass and fat-free mass between the two methods across these three groups.

Materials and Methods

An observational cross-sectional study involving adult patients with type 2 diabetes mellitus was performed with the aim of assessing the body composition using a BIA (Tantia BC-601, Tanita Corporation, Japan) and DXA (GE Lunar Prodigy, GE HealthCare) and comparing the subsequent values for a correlation between the two devices.

All procedures performed in this study followed the principles laid down by the Declaration of Helsinki (2013). Adult (age ≥18 years) subjects with type 2 diabetes mellitus attending the endocrinology outpatient department (OPD) of IPGME and R and SSKM Hospital, Kolkata, and giving written informed consent to participate in the study, were included in the study, and patients suffering from chronic liver disease and chronic kidney disease were excluded. A pilot study was conducted initially to calculate the probable ICC, which was then used to calculate the sample size using the tables in the research published by Temel *et al*.[17]

Thirty participants were chosen randomly from the diabetic patients attending the endocrinology outpatient's department to be a part of the pilot study. Using Statistical Package for the Social Sciences (SPSS) version 26, the ICC for the pilot study was found to be 0.871. Using Table 4 of the study by Temel *et al*.,[17] taking two independent raters (value of k = 2 in the table) and assuming an alpha error value of 0.01 and a beta error value of 0.20, the final sample size was found to be 52. We have finally collected data from 60 subjects, thus exceeding the minimum requirement for the sample size.

Data from the subjects of the pilot study were included in the final study. Simple random sampling was used to select the subjects for the study.

Parameters calculated by the BIA device included fat percentage (%), muscle mass (kg), bone mass (kg), metabolic age (years), total body water (%) and visceral fat level. Fat mass (BIA) was calculated from the total body weight and the BIA fat percentage values. Parameters calculated by the DXA device included fat percentage (%), fat mass (g), lean mass (g) and bone mineral content (g). The above DXA parameters were reported for the following body compartments: arms (left and right), legs (left and right) and trunk (left and right). However, such a compartmentalisation of parameters was not performed by the model of BIA used in our study. Appendicular lean mass (DXA) was calculated by adding the lean masses of arms and legs (in g) measured by DXA. The appendicular lean mass index (DXA) was calculated using the formula appendicular lean mass/height.[2] Appendicular soft tissue mass (DXA) was calculated by subtracting bone mineral content from the

appendicular lean mass values. Fat-free mass for both BIA and DXA was calculated by subtracting the respective fat masses from the total body weight. Notably, visceral adipose tissue (VAT) mass (in g) and volume (in cm^3) were reported by the model of DXA used in the study. The model of BIA used, however, reported a qualitative 'visceral fat level'. The visceral fat level values reported by Tantia BC-601 range from 1 to 59. According to the product manual, a value of 1–12 is considered a 'healthy level' and a value of 13–59 is considered an 'excessive level'. Visceral fat measured by BIA was reported in a qualitative way and that by DXA was in a quantitative way. Also, we have not been able to find any corresponding quantitative value for the qualitative visceral fat levels reported by BIA. Therefore, we have not been able to calculate a correlation for this parameter between the two machines.

The above-mentioned values were distributed across three BMI groups (according to the World Health Organization (WHO) Asian BMI classification): BMI <23 (non-overweight non-obese), 23 ≥BMI <25 (overweight) and BMI ≥25 (obese). ICC was calculated using SPSS (version 26) for fat mass and fat-free mass between BIA and DXA for each of the three groups and overall.

Proportions of males and females satisfying the quantitative criteria for sarcopenia laid out by the European Working Group on Sarcopenia in Older People (EWGSOP2) in 2018 (7 and 5.5, respectively) were calculated.[18] IBM SPSS (version 26) was used for analysis. A *P*-value of <0.05 was considered statistically significant in this study. An ICC of 0.21 to 0.40 was considered to mean fair agreement, between 0.41 and 0.60 as moderate agreement, between 0.61 and 0.80 as substantial agreement and between 0.81 and 1.00 as almost perfect agreement.[19]

Ethical aspects

Ethical clearance was obtained from the IPGME&R Research Oversight Committee (Institutional Ethics Committee) vide memo number IPGME&R/IEC/2021/606 dated 29 November 2021. Written informed consent was obtained for participation in the study and use of patient data for research and educational purposes. This study was conducted following the principles of the Declaration of Helsinki (1964).

Results

Table 1 shows that most participants belonged to the 'obese' BMI category. Overall, more females participated in the study than males. Patients living in urban and rural areas participated in almost similar numbers. A point worth noting is that patients in the obese group had the lowest values of fasting blood sugar and postprandial blood sugar. Also, their duration of diabetes was shorter than the other two groups. The most common comorbidity was hypertension, which was present in around a third of the population.

Table 2 elaborates on the values obtained by BIA and DXA while measuring various body composition parameters, namely fat percentage, muscle mass, bone mass, metabolic age, total body water and visceral fat level by BIA and fat percentage, lean mass, bone mineral content, fat mass and appendicular lean mass. Fat mass (BIA) was calculated from the total body weight and the BIA fat percentage values. The appendicular lean mass index (DXA) was calculated using the formula appendicular lean mass/$height^2$. Appendicular soft tissue mass (DXA) was calculated by subtracting bone mineral content from appendicular lean mass values.

Sarcopenia is a generalised and progressive disorder of skeletal muscle that is associated with increased chances of fractures, falls, physical disability and mortality. The EWGSOP2 published an updated guideline for identifying sarcopenia in 2018. It recommended using low muscle strength as the primary factor to suspect sarcopenia. The diagnosis is confirmed by documented low muscle mass (like the Appendicular Lean Mass Index). When reduced muscle function is present along with the other two criteria, sarcopenia is severe.[18] An appendicular lean mass index (ALMI) cut-off value of 7 kg/m^2 for men and 5.5 kg/m^2 for women was suggested by this group. In our population [Table 3], a larger fraction of men (about 39%, 9 out of 23) satisfied the muscle mass (quantitative) criteria for sarcopenia than women (about a fourth). Interestingly, despite only two (around 3%, who were also sarcopenic) subjects being underweight (BMI less than 18.5), a large proportion of the population (as stated above) satisfied the quantitative criteria for sarcopenia.

Table 4 tabulates the ICC calculated for fat-free mass and fat mass between BIA and DXA across the three BMI groups and overall.

When looking at the entire population, the ICC between DXA and BIA for fat mass and fat-free mass measurement was 0.949 and 0.924, respectively, which are considered to be in almost perfect agreement.

The ICC between DXA and BIA for fat mass between the three BMI groups revealed substantial agreement (0.769) for BMI <23 (non-overweight non-obese), almost perfect agreement (0.923) for BMI ≥25 (obese) (both of which were statistically significant) and fair agreement (0.239) for 23 ≥BMI <25 (overweight) (although not statistically significant).

The ICC between DXA and BIA for fat-free mass between the three BMI groups revealed almost perfect agreement (0.862 and 0.935, respectively) for groups: BMI <23 (non-overweight non-obese) and BMI ≥25 (obese) (both statistically significant). Substantial agreement (0.750) was found in the group: 23 ≥BMI <25 (overweight) (although not statistically significant).

Table 5 tabulates the ICC calculated for fat-free mass and fat mass between BIA and DXA for males and females, different age groups (21 to less than 40, 40 to less than 60 and above 60), controlled and uncontrolled diabetes and duration of diabetes (5 years or less, 5 to 10 years and more than 10 years), respectively. The ICC for fat and fat-free mass in all these groups showed almost perfect agreement (all more than 0.81 and all statistically significant) between BIA and DXA.

Table 1: Anthropometric and demographic data across the three BMI groups (and overall)

	BMI <23 (non-overweight non-obese) (*n*=18)	23≥ BMI <25 (overweight) (*n*=5)	BMI ≥25 (obese) (*n*=37)	Entire study population
Gender/sex (male/female)	7/11	4/1	12/25	23/37
Age (in years)*	48.17±9.29	52.20±8.47	46.59±9	47.53±9.04
Height (in cm)*	156.72±6.8	155.40±3.19	154.35±8.56	155.15±7.73
Weight (in kg)*	51.48±5.29	57.38±1.90	68.64±8.86	62.56±10.92
Rural/urban	10/8	2/3	19/18	31/29
Numbers of patients with comorbidities (type)	14 (hypertension)	4 (hypertension)	5/5 (hypothyroidism/ hypertension)	5/23 (hypothyroidism/ hypertension)
Duration of diabetes (in months)*	77.78±72.74	69.60±29.88	74.39±69.87	74.96±67.50
Fasting blood sugar (in g/dl)*	181.78±83.94	182±44.46	155.24±57.08	165.43±65.74
Postprandial blood sugar (in g/dl)*	287.83±111.69	289.20±103.28	247.19±93.28	262.88±100.15

BIA=Bioelectrical impedance analyser, DXA=Dual-energy X-ray absorptiometry, BMI=Body mass index. *Values are expressed as mean±SD

Table 2: Various body composition parameters as measured by BIA and DXA across the three BMI groups

	BMI <23 (non-overweight non-obese) (*n*=18)	23≥ BMI <25 (overweight) (*n*=5)	BMI ≥25 (obese) (*n*=37)	Entire study population (*n*=60)
BIA fat percentage (%)*	23.28±6.81	26.26±5.79	36.11±9.29	31.44±10.2
BIA muscle mass (in kg)*	37.40±5.08	40.06±4.49	41.45±8.45	40.14±7.47
BIA bone mass (in kg)*	2.13±0.29	2.30±0.16	3.14±4.56	2.77±3.6
BIA metabolic age (years)*	35.28±7.13	44.40±11.72	57.86±12.10	49.97±14.86
BIA total body water (%)*	53.50±5.09	52.7±3.59	46.82±5.45	49.31±6.08
BIA visceral fat level (no unit)*	5.83±2.50	9.6±3.36	11.08±2.93	9.38±3.67
DXA fat percentage (%)*	29.73±6.95	30.76±5.05	39.6±6.37	35.90±7.93
DXA lean mass (in kg)*	34.49±4.60	37.91±3.83	39.89±6.92	38.10±6.50
DXA bone mineral content (in kg)*	1.83±0.28	1.97±0.21	2.05±3.81	1.97±0.35
Appendicular lean mass (in kg)*	17±3.51	16.99±4.38	15.98±3.7	16.37±3.67
Appendicular lean mass index (ALMI) (kg/m^2)*	6.88±1.18	7.07±1.41	6.63±1.21	6.74±1.20
Appendicular soft tissue mass (in kg)*	15.98±3.35	16.05±4.09	15.04±3.54	15.41±3.50
DXA fat mass (in kg)*	14.63±3.62	16.77±2.46	26.06±5.53	21.86±7.22
DXA fat-free mass (in kg)*	36.24±4.90	39.89±3.99	41.84±7.19	39.99±6.78
BIA fat mass (in kg)*	11.98±3.52	14.99±2.92	24.79±7.64	20.13±8.71
BIA fat-free mass (in kg)*	39.50±5.37	42.39±4.64	43.86±8.83	42.43±7.82

BIA=Bioelectrical impedance analyser, DXA=Dual-energy X-ray absorptiometry, BMI=Body mass index. *Values are expressed as mean±SD

Table 3: Values of ALMI in males and females and the proportion of each satisfying the quantitative criteria for sarcopenia

	Male (*n*=23)	Female (*n*=37)
Appendicular lean mass index (ALMI) (kg/m^2)*	6.94±1.31	6.62±1.13
Number of participants satisfying the ALMI cut-off value for sarcopenia (7 for males and 5.5 for females) (%)	9 (39.13)	9 (24)

*Values are expressed as mean±SD

Discussion

In our study, we calculated ICCs for fat mass and fat-free mass measured by DXA and BIA across the three BMI groups and for the entire study population.

BIA and DXA agreed almost perfectly for fat mass and fat-free mass (ICCs 0.949 and 0.924, respectively) (statistically significant) when calculated for the entire study population.

Although fat mass showed only fair agreement (ICC = 0.239, P = 0.394) in the overweight group and substantial agreement (ICC = 0.769, P = 0.001) in the non-overweight non-obese group, it showed almost perfect agreement (ICC = 0.923, P = 0.001) in the obese (BMI ≥25) group. The low agreement in the overweight group might be due to the low number of patients present in the group (5 out of a total of 60).

This is in line with the study conducted by Fakhrawi *et al*.[7] on thirty-three postmenopausal overweight or obese with a mean BMI of 33.1 ± 5.7 kg/m^2. In his study, he found strong correlations (0.980 and 0.926) between fat mass and fat-free mass values measured by the Rudolph J. Liedtke (RJL) Sciences Quantum II system BIA and the fan beam Hologic DXA. Contrary to this, González-Ruíz *et al*.,[4] in their study on Colombian children and adolescents with excess adiposity, found poor agreement between BIA (both foot-to-foot BIA (Tanita® BC 420MA) and hand-to-foot BIA (Seca®

Table 4: Intra-class coefficients between fat mass and fat-free mass measured by *BIA and *DXA with their respective *P*-values and 95% confidence intervals

	*BMI <23 (non-overweight non-obese) (*n*=18)	23≥ *BMI <25 (overweight) (*n*=5)	*BMI ≥25 (obese) (*n*=37)	Entire study population (*n*=60)
*ICC for fat mass	0.769	0.239	0.923	0.949
P	0.001	0.394	0.001	0.001
95% confidence interval	0.932–0.073	0.917–3.959	0.961–0.842	0.975–0.878
*ICC for fat-free mass	0.862	0.750	0.935	0.924
P	0.001	0.077	0.001	0.001
95% confidence interval	0.966–0.091	0.972–0.425	0.971–0.827	0.968–0.722

*ICC=Intra-class correlation coefficient, BMI=Body mass index, BIA=Bioelectrical impedance analyser, DXA=Dual energy X-ray absorptiometry

Table 5: Intra-class correlation coefficients between fat mass and fat-free mass measured by *BIA and *DXA with their respective *P*-values and 95% confidence intervals (for males and females, different age groups, controlled and uncontrolled diabetes and duration of diabetes)

	*ICC for fat mass	*P*	95% confidence interval	*ICC for fat-free mass	*P*	95% confidence interval
Gender						
Males (*n*=37)	0.967	0.001	0.983–0.937	0.840	0.001	0.920–0.676
Females (*n*=23)	0.849	0.001	0.9610.119	0.853	0.001	0.965–0.148
Age group						
Ages 21-<40 (*n*=16)	0.963	0.001	0.987–0.894	0.878	0.001	0.957–0.662
Ages 40-<60 (*n*=41)	0.941	0.001	0.976–0.797	0.929	0.001	0.976–0.580
Ages above 60 (*n*=3)	0.851	0.042	0.996–0.245	0.969	0.001	0.999–0.016
Diabetes control						
Controlled (*n*=17)	0.891	0.001	0.971–0.238	0.939	0.001	0.985–0.380
Uncontrolled (*n*=43)	0.961	0.001	0.980–0.922	0.914	0.001	0.962–0.758
Diabetes duration						
5 years or less (*n*=33)	0.948	0.001	0.976–0.875	0.896	0.001	0.958–0.668
5 years to 10 years (*n*=17)	0.962	0.001	0.988–0.841	0.964	0.001	0.991–0.655
>10 years (*n*=10)	0.936	0.001	0.985–0.720	0.937	0.001	0.986–0.650

*ICC=Intra-class correlation coefficient, BIA=Bioelectrical impedance analyser, DXA=Dual energy X-ray absorptiometry

mBCA 514)) and the reference DXA method. It can be argued that the difference was found because of the different age groups used in this study compared with ours. Since there was also an almost perfect agreement (0.935, $P < 0.05$) between the fat-free masses measured by BIA and DXA in the obese group of our study population, BIA might be used interchangeably with DXA in measuring body composition in adult obese patients with type 2 diabetes mellitus.

The ICC between DXA and BIA for fat-free mass between the three BMI groups revealed almost perfect agreement (0.862 and 0.935, respectively) for groups: BMI <23 (non-overweight non-obese) and BMI ≥25 (obese) (both statistically significant). Substantial agreement (0.750) was found in the group: 23 ≥BMI <25 (overweight) (although not statistically significant).

The fact that there were substantially fewer people in the overweight group could explain the absence of significance in the ICC between the two methods. In a similar study by Beeson *et al*.[13] on Hispanic patients with type 2 diabetes mellitus, high values of Pearson's and Spearman's rank correlation coefficients were found for % fat mass, fat mass and fat-free mass between BIA (Tantia TBF-310) and DXA. They concluded that Tantia-BIA might provide valid measures of fat, per cent body fat and fat-free mass in Hispanic patients with type 2 diabetes mellitus and could be a convenient and practical approach for assessment in community-based research. A study conducted on Indian patients with chronic pancreatitis and diabetes mellitus found that there was a good correlation between DXA and BIA in measuring total fat mass.[14] In another study involving patients with insulin-dependent diabetes mellitus, where a regression model was developed incorporating the ratio of height squared to the minimum resistance of four limb-lead combinations, weight-sex interaction and total body weight, a good correlation was found between BIA and DXA.[12]

An interesting study published in 2018 has probed into the correlation of fat mass and fat-free mass values between BIA and DXA after having classified the population (consisting of adult patients followed up for malnutrition, obesity or eating disorders) according to BMI classes. They have found a strong correlation and concordance for fat mass estimated by BIA and DXA irrespective of BMI.[9]

Kawakami *et al*.[8] designed a similar study including Japanese patients with chronic renal failure, osteoporosis and diabetes

with obesity and found a good correlation (0.959 and 0.963, respectively) for total fat mass and total lean mass between BIA and DXA. A study to compare body composition measurements in maintenance haemodialysis patients by the two methods was performed and found close correlations for all BIA and DXA values, particularly fat-free mass.[6]

Unlike the above-described studies, which have shown a good correlation between values measured by BIA and DXA in patients with type 2 diabetes mellitus and other patients, there are a few which have not.

For example, a study conducted by Nigam *et al*.,[3] which compared DEXA-derived body fat measurement to two race (Asian and Caucasian)-specific BIA (Tanita MC-180 MA) equations in 200 apparently healthy Indians, found a poor absolute agreement with large bias and wide limits of agreement for % body fat. It can be argued that their study population consisted of healthy adults, whereas ours were subjects with type 2 diabetes mellitus, which could have resulted in the disparity with our results.

High correlation values suggest that BIA can be used in place of DXA to measure the body composition of adult diabetic patients across non-overweight non-obese and obese BMI groups. However, BIA has not shown a high correlation with DXA in measuring fat and fat-free mass in overweight patients. One reason could be the low number of patients representing the population in our study. Thus, we suggest performing further studies in a larger population of overweight patients with type 2 diabetes mellitus to compare the utility of BIA as compared to DXA and make a statistically sounder observation. High correlation values for fat mass and fat-free mass measurements, across genders, various age groups, diabetes control statuses and various durations of diabetes, between BIA and DXA, suggest interchangeable use of the two methods when these parameters vary.

Sarcopenia refers to a generalised and progressive loss of muscle mass along with the decline of muscle performance, which is also associated with the loss of muscle strength.[20] It is an inherent outcome of ageing.[21,22] However, certain chronic diseases, such as type 2 diabetes mellitus, have been shown to also predispose to sarcopenia. In certain studies, diabetic individuals have been found to be many times more likely to have sarcopenia than their healthy peers.[23-25] Insulin resistance and oxidative stress might be contributory factors in this regard.[26-28] We have been able to calculate Appendicular Lean Mass Indices (ALMIs) of patients from parameters measured by DXA. Similar to other studies, a large proportion (almost 39%) of males and females (24%) in our study population satisfy the quantitative part of the sarcopenia defining criteria by the EWGSOP2.[18,23-25] However, unlike the above-mentioned studies, we have not used a control group to be able to comment if sarcopenia in our study population is higher than in the non-diabetic population. Interestingly, despite only two (around 3%, who were also sarcopenic) subjects being underweight or lean (BMI less than 18.5), a large proportion of the population (as stated above) satisfied the quantitative criteria for sarcopenia. This points to the possibility of type 2 diabetes mellitus being the factor contributing to the sarcopenia in the study population. Therefore, further studies with this as the primary objective need to be conducted. The decline in muscle mass and strength leads to reduced mobility and increased incidence of falls and fractures, functional disability and dependence.[29,30] Sarcopenia in patients with type 2 diabetes mellitus is associated with a higher incidence of cardiovascular events, inpatient treatment and mortality.[29] Despite the acceleration of muscle loss in type 2 patients with type 2 diabetes mellitus, it is possible to reverse sarcopenia by early neuromuscular rehabilitation.[31] Early diagnosis and treatment of diabetes have also been shown to slow down the appearance and progression of sarcopenia.[32,33] Thus, early screening for sarcopenia in patients with type 2 diabetes mellitus should be explored in depth with the aim of improving their quality of life and reducing hospitalisations.

Conclusion

Based on the high ICC values between BIA and DXA, we suggest interchangeable use of the two methods in the non-overweight non-obese (BMI <23) and obese (BMI ≥25) BMI groups of adult patients with type 2 diabetes mellitus. However, the low correlation for all parameters in the overweight group points towards exercising caution when taking such measurements by BIA. One reason for the poor agreement could be the low number of subjects representing the population in our study, which might have been inadequate to find any significant agreement. We suggest planning a further study with a larger cohort of such individuals to better evaluate the said correlation.

It is also worthwhile to note that the value of ICCs will vary with the model of BIA and DXA used, and therefore, extrapolation of our results should be performed with caution when using models other than those used in this study. Further studies with different models of BIA and DXA can be conducted to better corroborate our results.

A high proportion of patients satisfying the quantitative criteria for sarcopenia (similar to studies conducted with controls) might give an indication that adult patients with type 2 diabetes mellitus are a potential area for intervention. This was an exploratory finding of the study, and further studies with a larger study population and a control group should be performed to be truly able to comment if sarcopenia is more prevalent in these patients.

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Author contributions

Concepts SGD, PG, DD, SC, Design SGD, PG, DD, SC, Definition of intellectual content SGD, PG, DD, SC, Literature search SGD, PG, DD, Clinical studies SGD, PG, DD, Experimental studies NA, Data acquisition SGD, PG, Data analysis SGD, DD, Statistical analysis SGD, PG, DD,

Manuscript preparation SGD, Manuscript editing SGD, PG, DD, SC, Manuscript review SGD, PG, DD, SC, Guarantor DD.

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Conflicts of interest

There are no conflicts of interest.

Data availability

None.

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