

Investigating Ethnic Differences In Total Body Fat Using Body Composition Analytical Methods

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Abstract: The reliable measurement and comparison of total body fat percentages (TBF%) via body composition analysis approaches in South Asian (SA), White (W), and Black African (BA) adults is largely undetermined. The purpose of the research is to assess the precision of TBF% across three distinct ethnic groups by implementing Tanita/bioelectrical impedance analysis (BIA) and Bod-pod/air displacement plethysmography (ADP). Design—30 healthy female university subjects. The following physical examinations had been taken: waist circumference (WC), hip circumference (HC), waist-to-hip ratio (WHR), body weight, height, and body mass index (BMI). The interquartile range (IQR) was used to acquire the levels of physical activity (PA). Findings—The mean TBF% from BIA was 28.15 in SA, 28.54 in W, and 34.17 in BA. And from ADP, 21.9 in SA, 15.4 in W, and 2.9 in BA. Tukey's test demonstrated that neither of the TBF% procedures showed any differentiation with *p*-values of 0.256, 0.09, and 0.506 by BIA and ADP, respectively. The Mann-Whitney test revealed that differences in TBF% appeared solely in SA vs BA; *p*-values were 0.023 by BIA and 0.011 by ADP. The TBF% methods did not exhibit a significant correlation with any of the ethnic cohorts. The SA individuals signified insufficient PA, with an IQR of 0 (MET-min/week) in moderate to vigorous physical activity (MVPA). Conclusion—BIA overestimates TBF more than the ADP. Consequently, neither method represents potential variation in TBF within all study groups, despite highlighting the disagreement between SA and BA.

Keywords: Ethnicities, Body composition methods, Total body fat percentage, Validity.

1. INTRODUCTION

The determination of the potential health peril associated with acquiring exceptional fluctuations of body fat (BF) requires reliable indicators of body composition **Error! Reference source not found..** There is a growing number of empirical investigations that incorporate bioelectrical impedance analysis (BIA) **Error! Reference source not found..** Specifically, proficiency in recognising differences between ethnic groups through body composition valuation. Along with describing significant disparities in the context of overweight and diseases among adult people **Error! Reference source not found..** Synchronously, accurate BF prediction has become vital due to the observed connection of high BF deposits and an abundance of disorders **Error! Reference source not found..** These conditions encompass an elevated ratio of fats in the blood, cardiovascular disease (CVD), and chronic illnesses such as diabetes mellitus (DM) and hypertension **Error! Reference source not found..** However, research on the body physique structure shall be executed, in which the constitution of body fat could have failed to be assessed **Error! Reference source not found..**

In accordance with the physical characteristics of the body, some ethnic groups are marginally or substantially more susceptible to metabolic disorders triggered by obesity **Error! Reference source not found..** Thus, compared to white Europeans (WE), South Asians (SA) displayed wider waist circumferences (WC), waist-to-hip ratios (WHR), and TBF regardless of BMI **Error! Reference source not found..** In the UK, the stroke fatalities in SA are significantly higher in contrast to WE **Error! Reference source not found..** Furthermore, in comparison with other races and ethnic minorities, SA encounters an increase in the prevalence of CVD, which is endangering **Error! Reference source not found..** That comprises type 2 DM, weight gain, metabolic diseases, and abnormal fat deposits. As well as high blood pressure, sugar, and lipid percentages, despite maintaining an appropriate weight **Error! Reference source not found..** SA tends to have an increased susceptibility to type 2 DM compared to WE, from 2 to 6-fold **Error! Reference source not found..** African and Caribbean adults are inclined to have complications from diabetes, stroke, and hypertension, whereas they exhibit stronger muscle mass along with decreased fat around the abdomen compared to WE **Error! Reference source not found..**

Nonetheless, numerous advanced techniques and strategies have been developed to evaluate the body's composition in practical contexts **Error! Reference source not found..** The running processes are obligated not exclusively to elucidate accuracy and uniformity to properly ascertain body composition. However, it has to be functional, convenient to operate, and capable of fulfilling a range of user expectations **Error! Reference source not found..** For example, two body composition methods, air displacement plethysmography (ADP) and BIA, have been more prevalent throughout the past 20 years due to their remarkable tangible benefits and flexible application **Error! Reference source not found..** The effectiveness of BIA in detecting BF is still obscure, contrary to its multitude of intriguing attributes **Error! Reference source not found..** Studies also suggest that various races may have varying BIA credibility **Error! Reference source not found..** But it's crucial to confirm that different body composition methods are essential **Error! Reference source not found..** BIA devices ordinarily utilise preset algorithms, involving BF, to figure out values **Error! Reference source not found..** Specific variables, including gender, ethnicity, age, tallness, and weight, were conjoined into the BIA metrics **Error! Reference source not found..** Alternatively, others in fields could employ these calculations to alter or illuminate BIA features instead of depending on laborious processes that include dual-energy X-ray absorptiometry (DEXA) to create trustworthy frameworks **Error! Reference source not found..** The scientific authenticity of foot-to-foot BIA (FF-BIA) against DEXA has been reinforced by some of the investigators **Error! Reference source not found..** In contrast to DEXA, which is exorbitant, arduous to apply with widespread community examinations, and concerned about radioactivity emission, FF-BIA has the advantages of being affordable, effective, and requiring basic expertise **Error! Reference source not found..** One of the most applicable and verifiable approaches to detecting fat content is the Bod-Pod, which was launched by ADP to be traded on the market **Error! Reference source not found..** Pediatrics, people with obesity, seniors, and those with incapacitation to walk can all be handled by the Bod-Pod, which has the distinct benefit of being a swift, appealing, remotely controlled, and secure way of assessing technique **Error! Reference source not found..** The effectiveness of ADP for a point of reference has been scrutinised in several kinds of research articles utilising DEXA **Error! Reference source not found..** In different racial groups, there is certainly insufficient evidence that supports the use of DEXA as a standard strategy **Error! Reference source not found..**

On the other hand, a research investigation enrolled one hundred ten volunteers from a diverse range of origins, comprising Asian, White, Black, Hispanic, and multi-ethnic populations **Error! Reference source not found..** They reported that the models of the deuterium dilution 3-compartment (D2O 3C), bioelectrical impedance spectroscopy 4-compartment (BIS 4C), and bioelectrical impedance spectroscopy 3-compartment (BIS 3C) provided the highest quality responders when determining BF% and fat-free mass (FFM) across any ethnic group **Error! Reference source not found..** Afterwards, the others were BIS, in-body (IB), ADP, and DEXA. The BIS data were misleading for Black, White, and multi-ethnic subjects, even though there were no appreciable differences in results between the study groups **Error! Reference source not found..** The appraisal of BF% using DXA or the 5-Compartment Model had a favourable relationship, but it failed to demonstrate the difference through methods in a cohort of twenty-seven participants (White, Black, and Puerto Rican) **Error! Reference source not found..**

In line with previous concepts, BF% from multiple races can potentially be properly estimated via ADP and DEXA **Error! Reference source not found..** However, because it was powerless to identify the type of ethnicity, it continues to be ineffectual concerning Asian and Hispanic people **Error! Reference source not found..** An extensive array of ethnic designations, notably South Asian, draws attention to the autonomous pursuit of certain racial groups, which will be important in prospective studies **Error! Reference source not found..**

The pattern of BF is likely to vary significantly between Europeans, Asians, Americans, and Africans. The BF% monitored by the BIA diverged remarkably from the BIA-anticipated calculations. As was indicated by the outcomes of a research investigation that included a total of 1128 (574 female and 554 male) Black and White South African young people **Error! Reference source not found..** Minority demographics, who are particularly hit by the elevated risk of incidence of fatness, CVD, and metabolic health issues, require conclusive body composition screening and surveillance, necessitating re-evaluations **Error! Reference source not found..** The vast majority of earlier body composition analyses failed to properly identify the backgrounds and ethnicities of people, or left out the minority groups **Error! Reference source not found..** Such as **Error!**

Reference source not found., Error! Reference source not found., and Error! Reference source not found.. Alternatively, only one ethnic group was identified as the subject of study inclusions Error! Reference source not found., Error! Reference source not found., Error! Reference source not found.. and Error! Reference source not found.. Or implemented at younger ages Error! Reference source not found., Error! Reference source not found., and Error! Reference source not found.. Since body characteristics may vary between individuals' origins, causing deceptive assessments, these shortcomings must be rectified Error! Reference source not found..

The primary goal of this current research is to employ ADP and BIA technologies to determine the precision and inconsistency of total body fat in multiethnic female adults with SA, W, and BA. The study will also examine the relationship between physical activity intensity and the occurrence of illnesses and excess body fat in various ethnic groups.

2. METHODOLOGY

2.1 Study Design

A cross-sectional investigation has been performed by participants attending the Whitelands College at Roehampton University, London, United Kingdom (UK). In a single lab session, all analyses and evaluations had been done. Every individual provided an informed written agreement, and before initiating the process of measuring, the guidance was delivered. In case a participant felt unwilling to oblige themselves to continue in the study, they could withdraw at any point.

2.2 Study Subjects

This study recruited a total of thirty individuals from multi-ethnic origins, including ten from each of the following groups: as shown in Table 1. Eligibility requirements focused on being a woman, between the ages of 18 and 65, and having good health. A self-identified computing inspection was used to ascertain the ethnic heritage of the participants. Nine out of the thirty people who took part in the study submitted the electronic short-version exercise survey.

Table 1: Demographic features of study participants.

South Asian (SA)=10	White European (WE)=10	Black African- Caribbean (BAC)=10
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2.3 Anthropometric Screening

Anthropometric measurements of the body included a straightforward formula for metric units (kilogram and metre), which was used to compute body mass index (BMI): $BMI = \text{weight (kg)} / [\text{height (m)}]^2$. Height was measured using a portable stadiometer (Holtain Ltd, Pembs, UK) to the nearest 0.1 cm. Body weight was measured using an SECA electronic scale (SECA, Hamburg, Germany) to the nearest 0.1 kg, and the weight of the clothes was subtracted by 0.2 to 0.8 according to the type of clothing worn. Waist circumference (WC) was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest. Hip circumference (HC) was measured around the widest portion of the buttocks. A SECA measuring tape was used for both measurements. The subjects had been advised to stand with their feet near each other. The upper limbs at their sides, body weight dispersed properly, and to utilise light clothes. The subject ought to be comfortable, and the measurements need to be taken right next to the last of typical air expiration. The waist-to-hip ratio (WHR) was identified to divide the WC by the HC [12].

2.4 Body Fat Assessment

Involved the Bioelectrical Impedance Analysis (BIA) and Air-Displacement Plethysmography (ADP) The TANITA BC-418 MA (Tanita Corp., Tokyo, Japan) procedure was utilised for estimating TBF%, known as BIA. This type of evaluation is regarded as innovative in the analysis of body segmentation. TBF%, fat mass (FM), and FFM are the three recorded fractions in the device. The regional TBF and the intended BF values are offered as well as by the apparatus. Each subject stood with a naked foot on the steel footpads. They clutched the machine handgrips slightly while the arms rested at their sides. Next, the clothing's load was deducted. After that, the sex and fitness level of the body were entered: regular or sportive, man or woman. The impedance was evaluated once the stature and age were registered, then the tool exhibited the TBF% and generated it. Approximately one minute is allotted for the examination.

The published guidelines by Donoghue (1989) implemented another evaluation for TBF%. The ADP protocol demands a person to be seated gently inside a chamber for no more than three minutes, whereas the body figures out and detects the TBF. The procedure lasted roughly ten minutes, outcome data were immediately presented, and the involved subjects were advised to wear lightweight clothes and head swim hats.

2.5 Analysing workout levels.

The International Physical Activity Questionnaire (IPAQ) is a brief, independently administered survey developed mainly to assess levels of physical activity performed during the previous week. These questionnaires' main goal is to furnish uniform methods that produce insights into ranges of activity related to health impact that are similar worldwide.

This format has been affirmed broadly and is capable of quantifying the number of activity days in a week as well as the interval of time spent engaging in each day. All forms of physical activity, including walking, moderate physical activity (MPA), and vigorous physical activity (VPA), are assessed independently. The activities must be conducted for at least 10 uninterrupted minutes in all pertinent situations, like residence, place of work, and recreation areas, and they must be assessed in a span of one week.

Metabolic equivalents (MET-hours/week) are determined by using the IPAQ and obtained by allocating defined MET scores of 3.3 for walking, 4 for moderately strenuous activities, and 8 for vigorous-intensity activities.

The guidelines that follow are incorporated to create these categories:

1. Low/insufficient active: not pointed as high or moderately.
2. Moderately/sufficiently active: satisfying no less than 1 out of 3 standards and conforming to the minimal Physical activity requirements:

Exercising strongly for no fewer than 20 minutes for a minimum of 3 consecutive days.

Engaging in no less than 5 days of walking or moderately rigorous exercise for at least half an hour/day.

Completing no less than 5 days of walking or moderate- or vigorous-intensity physical activities (MVPA) in any integration that sums to no fewer than 600 MET-minutes/week.

3. Highly/more sufficiently active: meeting one of two requirements:

Committing to no less than 3 days of intense exercise per week and achieving no fewer than 1500 MET-minutes/week.

Any set of walking or MVPA for no less than 7 days and getting no fewer than 3000 MET-minutes/week.

2.6 Statistical Analysis

SPSS software version 28.0 was implemented to carry out mathematical computations of the data. To explore the descriptive data of the variance and normality of the subject's features, we used a statistical strategy. The difference in TBF% between Tanita-BIA and Bod-Pod across ethnic groups was investigated employing a one-way ANOVA, followed by the Tukey post hoc analysis. To find the significant differences, the outcomes were confirmed and integrated with the Kruskal-Wallis and Mann-Whitney tests. Each ethnic sample's correlation with the TBF% techniques was examined using Spearman's correlation. The measure of statistical dispersion was used to evaluate the IPAQ.

2.7 Ethical Approval

The research work adheres to the Helsinki criteria set by the World Medical Association, along with all practices about people that have been certified by the Ethical Board (Ref. LSC 20/321) at the University of Roehampton.

3. RESULTS AND DISCUSSION

This research paper intends to evaluate the reliability and variability of body fat by implementing body composition techniques, BIA and ADP, in female adults from South Asian (SA), White (W), and Black African (BA) backgrounds. The statistical characteristics for the average mean, variance, standard deviation, lowest, and highest values are represented in Table 2. Table 2 A shows the SA group with a mean age of 25.3 ± 2.11 years. The average weight was 61.53 ± 19 kg and height 160.3 ± 6.3 cm, corresponding to a mean BMI of 23.9 ± 6.34 kg/m². Mean WC was 77.1 ± 12.1 cm, and HC was 97.32 ± 14.6 cm, with a WHR of 0.79 ± 0.05 . TBF measured by BIA was $28.15 \pm 8.9\%$, while ADP showed a slightly lower mean of $27.3 \pm 7.18\%$. Table 2B outlines the W group with a higher mean age of 33.3 ± 12 years. Their average weight was $61.2 \pm$

8.3 kg and height 162.5 ± 9.1 cm, giving a BMI of 23.3 ± 3.9 kg/m². The mean WC was 76.5 ± 6.04 cm, HC 98.5 ± 9.18 cm, and WHR 0.77 ± 0.05 . TBF was $28.5 \pm 9.8\%$ by BIA and $25.8 \pm 9.2\%$ by ADP. Table 2C displays the BA group with a mean age of 23.5 ± 3 years. The average weight was 68.1 ± 9.7 kg and height was 164.7 ± 7.6 cm, with a BMI of 25.3 ± 4.24 kg/m². The mean WC was 80.6 ± 12.9 cm, HC 102.5 ± 9.9 cm, and WHR 0.78 ± 0.05 . TBF% was higher compared to the other ethnic groups at $34.1 \pm 5.7\%$ by BIA, while ADP (based on a single available value) showed 29.3%.

The BA group was younger, with a mean age of (23.5 years), compared to SA (25.3 years) and W (33.3 years). Height was slightly greater in the W and BA groups (≈ 162 – 165 cm) than in SA (160 cm). The BA group had a higher average weight and BMI (68.1 kg; 25.3 kg/m²) compared to SA (61.5 kg; 23.9 kg/m²) and W (61.2 kg; 23.3 kg/m²). WC and HC were also larger in BA, while WHR values were similar across groups (0.77–0.79). TBF% by BIA was highest in BA (34.1%) compared to SA (28.15%) and W (28.5%), with ADP values showing the same trend, although slightly lower. Only one ADP valid measurement was available for the BA group (29.30%), limiting comparative interpretation for this group. The TBF% derived from the ADP measurement procedure was applied to 15 out of 30 data sets, dropping two SA, four W, and nine BA. This raises a key planned aspect.

Table 2: Analysis of frequencies by subgroup.

SA	Valid	Missing	Mean	Std	Variance	Min	Max
Age	10	0	25.3	2.11	4.5	22	28
Weight	10	0	61.53	19	365	46	112
Height	10	0	160.3	6.3	40	153	170
BMI	10	0	23.9	6.34	40.2	19	40
WC	10	0	77.1	12.1	148.1	63	102
HC	10	0	97.32	14.6	212.9	82	132
WHR	10	0	0.79	0.05	0.003	0.72	0.88
TBF-BIA	10	0	28.15	8.9	79.2	18.9	48.6
TBF-ADP	8	2	27.3	7.18	51.62	16	37

W	Valid	Missing	Mean	Std	Variance	Min	Max
Age	10	0	33.3	12	143.8	21	56
Weight	10	0	61.2	8.3	69	47.3	73
Height	10	0	162.5	9.1	83	149	178
BMI	10	0	23.3	3.9	15.34	19	30
WC	10	0	76.5	6.04	63.5	69	85
HC	10	0	98.5	9.18	84.36	87	115
WHR	10	0	0.77	0.05	0.004	0.70	0.87
TBF- BIA	10	0	28.5	9.8	95.7	17	44.4
TBF-ADP	6	4	25.8	9.2	84.8	16	42

BA	Valid	Missing	Mean	Std	Variance	Min	Max
Age	10	0	23.5	3	9.17	20	29
Weight	10	0	68.1	9.7	94.03	56.6	86
Height	10	0	164.7	7.6	57.34	154	177
BMI	10	0	25.3	4.24	17.9	18	32
WC	10	0	80.6	12.9	168.6	63.5	108
HC	10	0	102.5	9.9	97.36	91	120
WHR	10	0	0.78	0.05	0.004	0.7	0.90
TBF-BIA	10	0	34.1	5.7	32.7	26	45.2
TBF-ADP	1	9	29.3	-	-	29	29

2A- SA: South Asian. Table 2 B- BA: Black African. Table 2 C- W: White. BMI: body mass index, WC: waist circumference, HC: hip circumference, WHR: waist to hip ratio, TBF: total body fat, BIA:

bioelectrical impedance analysis, ADP: air displacement plethysmography, Std: Standard Deviation, Min: minimum values, Max: maximum values.

The normality and statistical approaches were applied in Table 3. The majority of the variables, such as TBF% estimated by BIA, had a balanced distribution with a p of > 0.05 , as well as height, HC, and WHR. Figure A represents the BIA line, which suggests that these variables had an approximately normal distribution. On the contrary, both results showed a significant deviation from normality in age and TBF% from ADP, with a p of < 0.001 . The ADP line is displayed in Figure B. Beyond that, weight, BMI, and WC, with a p of 0.001, 0.007, and 0.036, respectively, didn't appear to be normally distributed.

Table 3: Normality/Distribution of study variables.

	Kolmogorov-Smirnov (KS) (KS)			Shapiro-Wilk (SW)		
	Statistic	Df	P-value	Statistic	Df	P-value
Age	0.303	30	< 0.001	0.686	30	< 0.001
Weight	0.139	30	0.145	0.863	30	0.001
Height	0.105	30	0.200	0.957	30	0.262
BMI	0.129	30	0.200	0.896	30	0.007
WC	0.123	30	0.200	0.925	30	0.036
HC	0.144	30	0.116	0.933	30	0.059
WHR	0.122	30	0.200	0.969	30	0.509
TBF-BIA	0.105	30	0.200	0.966	30	0.444
TBF-ADP	0.321	30	< 0.001	0.799	30	< 0.001

Df: degree of freedom, P-value: significance level or (p), BMI: body mass index, WC: waist circumference, HC: hip circumference, WHR: waist to hip ratio, TBF: total body fat, BIA: bioelectrical impedance analysis, ADP: air displacement plethysmography.

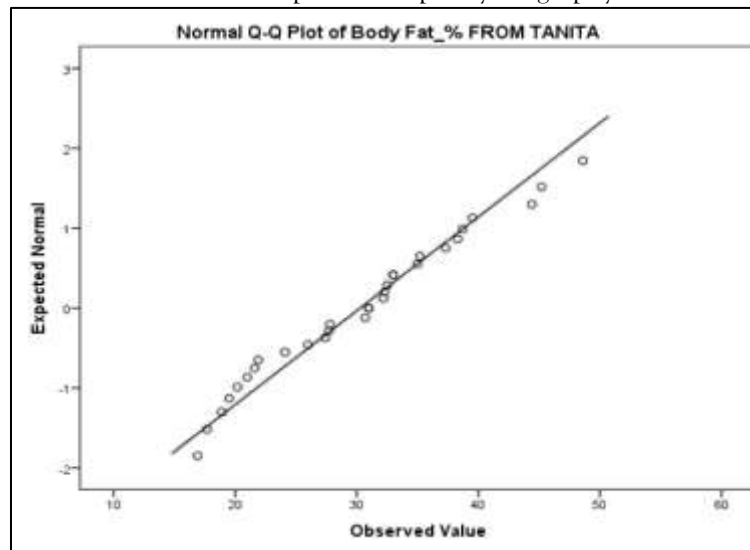


Fig. 1. Q-Q Plot assessing the normality of the body fat from bioelectrical impedance analysis (BIA).

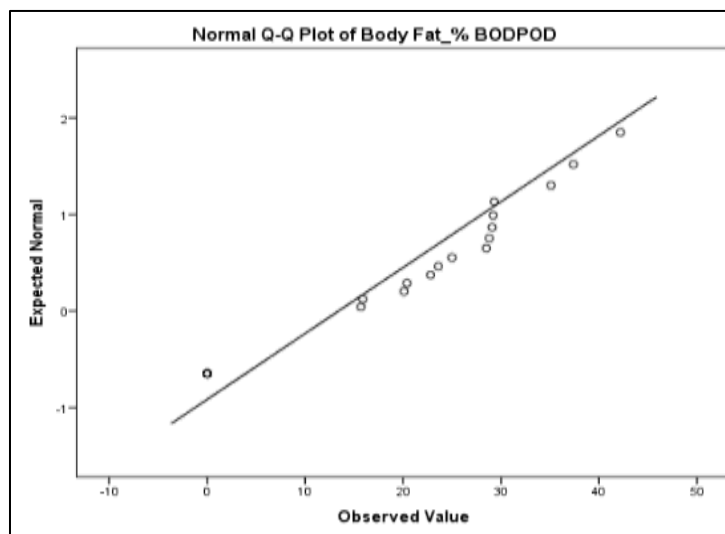


Fig. 2. Q-Q Plot assessing the normality of the body fat from air displacement plethysmography (ADP).

Based on the study analysis, the variation of TBF together with inter- and intra-groups appeared in Table 4. TBF by BIA does not differ significantly, with a ratio of 1.6 and p of 0.213. Meanwhile, there were prominent differences in TBF relative to the ADP, with a ratio of 5.8 and a p of 0.008. At the same time, the Tukey post hoc test affirmed the differentiation of the TBF in BIA. The mean was 28.15% for SA, 28.54% for W, and 34.17% for BA, with no significant group differences observed with a p of 0.256, revealing comparable TBF readings. In contrast, ADP showed wider variation in TBF across groups, with mean values of 21.9% for SA, 15.4% for W, and 2.9% for BA. Although the results were not statistically significant with a p of 0.09 and 0.506, as shown in Table 5, our preliminary results suggested that there was insignificant variation when applying the analysis of variance to quantify TBF% from BIA across three ethnic groups.

The profound effect of ADP on ethnicity was further demonstrated by the fact that individuals of SA had a superior TBF% compared to those of W heritage. The present investigation agreed with earlier research. For instance, an analysis of eighty SA subjects revealed that body adiposity index (BAI) and FF-BIA prediction of BF% were strongly correlated alongside Bod-Pod. Particularly when considering individuals who had a BMI > 21 kg/m². The relationship was weaker in individuals who had a BMI ≤ 21 kg/m². Therefore, contrasted with Bod-Pod, FF-BIA, and BAI undervalued BF% [15]. Although in our SA study group, BIA marginally overstated TBF% compared to the Bod-Pod. The difference between the approaches was unnoticeable; furthermore, the SA presented a consistent average BMI of more than 21 kg/m².

Simultaneously, almost all of the pairwise multi-comparisons outcomes demonstrated that ethnic groups were not significantly influenced by the TBF% tools. With a single exception in ADP, the difference was notable in SA and BA, with a p of 0.007, as summarised in Table 6 and detailed in Appendix A. An examination of 74 overweight or obese African females (AF) showed that measuring BF% from BIA and an innovative BMI computation was roughly the same as DXA data [11]. Furthermore, it was discovered that the previously used BMI and BIA algorithms [1], [2], [3], [4], and [5] were ineffective for accurately interpreting BF% in AF [11]. Correspondingly, a study of twenty-four overweight and obese Caucasian and Black females with BMI ranging from 25.0 to 29.9 kg/m² found a consistent BF%, FM, and FFM by applying ADP and DXA [17].

ADP provides a reputable and straightforward way of predicting BF%, FM, and FFM in Caucasian and Black females [17]. This study [17] supports the study's observations that the ratios of body fat evaluated by ADP had a negligible impact on Black and White people. Also, it was understood that there is a lack of true ADP data obtained by BA. Importantly, BA has an almost average BMI of more than 25 kg/m². These findings indicate that ADP is more robust than BIA for detecting the diversity of BF% in varied ethnic groups.

Table 4: A comparative analysis of body composition methods between ADP and BIA.

Measurers	Variation	SS	Df	MS	F	P-value
TBF-BIA	Between people	226.97	2	113.48	1.6	0.213
	Within people	1869.23	27	69.23	-	-
	Total	2096.19	29			
TBF-ADP	Between people	1860.7	2	930.32	5.8	0.008

Measurers	Variation	SS	Df	MS	F	P-value
	Within people	4355.5	27	161.31	-	-
	Total	6216.19	29			

One-way ANOVA. SS: Sum squares to measure the variability of differences between and within people, Df: degree of freedom between and within people, MS: mean squares SS/Df, F: MS between people/ MS within people, P-value: significant level or (p), BIA: bioelectrical impedance analysis, ADP: air displacement plethysmography.

Table 5: Evaluate the validity of BIA and ADP for estimating TBF.

Measurements	Groups	N	α	
			1	
BIA	SA	10	28.15	
	W	10	28.54	
	BA	10	34.17	
	P-value	0.256		
ADP	Groups	N	α	
			1	2
	SA	10		21.9
	W	10	15.4	15.4
	BA	10	2.9	
	P-value		0.09	0.506

Tukey HSD. α : alpha subset=0.05, P-value: significant difference or (p), BIA: bioelectrical impedance analysis, ADP: air-displacement plethysmograph, N: sample size, SA: South Asian, W: White, BA: Black African.

The differentiation concerning BA and SA is observable. A second examination was undertaken in an attempt to achieve alignment of the findings and to uncover instances of conflict in TBF% procedures within the study sample. BIA claims that there is no difference in the TBF%, with a p of 0.109. Whereas the difference is considerable with a p of 0.017 by ADP. To explore the degree of inconsistency identified by the Mann-Whitney test, the results demonstrate potential variations in TBF% between SA and BA. The p was 0.023 in BIA and 0.011 in ADP. Whereas, the differences were absent in other groups, with a p of 0.97 and 0.19 by BIA and 0.28 and 0.09 by ADP in SA vs W and W vs BA, respectively as clarified in Table 6. While assessing the Black community, the ADP device assumes enhanced propensity differences in terms of validity. However, these findings highlight the importance of selecting appropriate testing methods for accurate assessments.

The Spearman's rank correlation coefficients values for the variables obtained from the study groups were calculated as p 0.6 in SA, p 0.80 in W, and p 0.62 in BA. The findings suggest a negatively impuissant association across the TBF% when estimated by BIA and ADP, as presented in Table 6 and detailed in Appendix A.

These correlations are deemed statistically negligible, given that the p exceed the 0.05 threshold. As shown by the statistical relationship interpretation, there were significant failures with the association between body composition analysis techniques throughout all of the ethnic categories.

Table 6: Determine the differences in TBF across all ethnic groups and pairwise comparisons.

Comparison	Statistical test	BIA	ADP
Overall groups	Kruskal-Wallis	4.42	8.113
	Df	2	2
	P-value	0.109	0.017
SA and W	Mann-Whitney	49	35
	Wilcoxon W	104	90
	Z	-0.08	-1.149

	Asymp-Sig	0.94	0.25
	Exact-Sig	0.97	0.28
SA * BA	Mann-Whitney	20.5	17
	Wilcoxon W	75.5	72
	Z	-2.23	-2.73
	Asymp-Sig	0.26	0.006
	Exact-Sig	0.023	0.011
W *BA	Mann-Whitney	32	27
	Wilcoxon W	87	82
	Z	-1.36	-2.04
	Asymp-Sig	0.17	0.04
	Exact-Sig	0.19	0.09

Df: The Degree of Freedom, P-value: determined by the asymptotic range of the test statistical value or (p), BIA: bioelectrical impedance analysis, ADP: air-displacement plethysmograph, SA: South Asian, W: White, BA: Black African, Z: the Z score from unified analysis of data, Asymp-Sig: is the two-tailed p from the regular distribution, Exact-Sig: [2*(1-tailed Sig. 1)], the accurate p based on accurate probability.

Among SA participants, physical activity levels, as assessed using the IPAQ-SF, demonstrated very low engagement in vigorous and moderate activity. Both of them equalled 0, articulating that a significant proportion of the population did not engage in these two types of workouts. In contrast, walking displayed more significant progress with 346.5 (MET-min/week)

on the Weighted Average (WA). This suggests substantial variability in this behaviour; it is likely due to differences in commuting frequency among individuals. Also, walking was represented by the most common form of exercise, with an interquartile range of 99 (MET-min/week), as calculated by Tukey's Hinges (TH). Despite the rarity of higher intensity activities, walking accounted for the majority of physical activity kinds in the SA group, as described in Chart I.

This is in agreement with earlier research, based on the cultural, social, or lifestyle characteristics inherent to the South Asian community. The remarkably elevated rate of physical inactivity arises because some types are possibly harder to attain or more ubiquitous in the South Asian population.

These results presented conform to and elaborate on evidence from preceding research in the UK. A cross-sectional study involved two different ethnic groups with a total of 2843 White and 243 South Asian. They found that the IQR from MVPA levels and based on IPAQ were decreased in SA compared to W individuals (30 vs 51) (minutes/day), respectively. Alternatively, both groups had roughly identical MVPA ratios when assessed by the objective method: 18 for SA and 21.5 for W (minutes/day) **Error! Reference source not found..** Likewise, an additional study of 5474 adults declared that South Asians appear significantly less engaged in activity than White Europeans **Error! Reference source not found..** Indeed, aligned with their white counterparts, the South Asian participants reported an inferior level of PA. Furthermore, the evidence illustrates that only a few groups of the general population are physically active, recommending that a specific approach could be beneficial for targeting particular demographic groups. Moreover, this emphasises the need to create productive, culturally aware public health initiatives that encourage regular physical activity among minority groups. However, this declaration recognises that South Asians are more susceptible to both diabetes and CVD **Error! Reference source not found..**

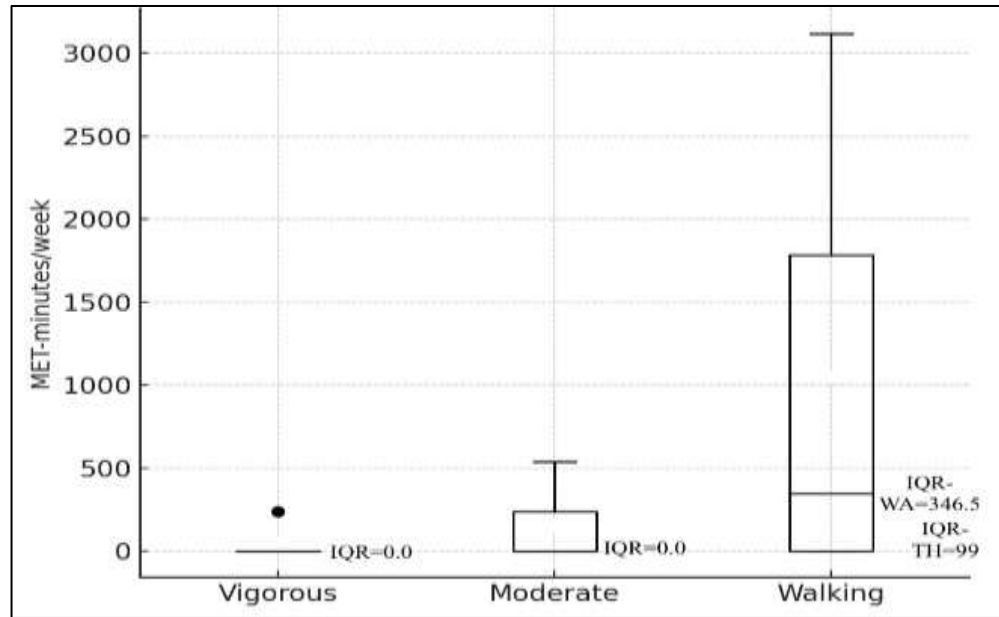


Chart I. Distribution of Physical Activity (MET-min/week) in South Asian.

Boxplot. WA: weighted average, some values contribute more to the final average than others = $\sum (xi \cdot wi) / \sum wi$, TH: tukey's hinges: descriptive statistic of the dataset and hinges refer to 25th percentile Q1, 75th percentile Q3, used to calculate the Interquartile range (IQR), MET-min/wk: metabolic equivalent of task-minutes per week.

The shortage of TBF% details, which particularly declined by half when using ADP technology, was the main barrier that the current investigation proclaims. The limited computational timeframe and individual usage of the tool could potentially explain this drawback. In addition, we only included women in our analysis, therefore narrowing the data's vitality to a specific sex. Next, the survey of the questionnaires restricts the data collection to 9 participants from South Asian. For this reason, the situation makes it difficult to compare the instances of physical activity among the three ethnic subgroups. To evaluate the proportions of workouts among various ethnic communities, an extensive enquiry must be conducted with a broad number of volunteers. Furthermore, substantial future studies are needed, such as males of varying races or ethnicities, as well as adequate periods to represent the body fat assessment, especially ADP.

The initial positive aspect of the research is that it remains reasonable to all ethnic groups, regardless of a relatively modest sample size. Then, in measuring TBF%, we also found significant links with the parameters of relevance, particularly WC, HC, and WHR. Comparative analyses across these parameters were regrettably outside of the study's purview.

Our study's observations have crucial potential consequences for scientific investigators who wish to figure out TBF% in diverse populations employing accurate body composition analysis methods.

4. CONCLUSION

There are no manifest racial disparities in the percentage of total body fat, regardless of ethnicity. Particularly, in South Asians and Blacks, the ADP depicted a significant difference twice, and the BIA did so once. Notably, the ADP showed a more beneficial advantage in distinguishing between Blacks and South Asians. Moreover, the poor correlations suggest a failure to maintain a coherent connection between the methods and the study samples. However, it is challenging to conclusively determine a credible correlation between various body fat assessments in distinct ethnic populations. Overall, prospective research is necessary to disclose whether discrepancies in physiology or analysis procedures contribute to increased vulnerability to a specific ethnic group.

5. Appendix



A-

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The author declares that there is no financial support, no conflict of interest to the best of my knowledge, and no author's contributions. Study ethical approval was obtained from the university ethics committee, and participants provided written informed consent to participate. The source of the dataset files is not included in the paper but is available upon request.

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