Journal of Advanced Research in Medicine
Volume 9, Issue 3 - 2022, Pg. No. 1-6
Peer Reviewed & Open Access Journal

Research Article

Matching Body Composition Confirms Decreased Phase Angle among Diabetics Compared to Controls

Harsharan Kaur[1], Omesh Kumar Bharti[1]

[1]State Institute of Health and Family Welfare, Parimahal, Kasumpti, Shimla, Himachal Pradesh, India.
DOI: https://doi.org/10.24321/2349.7181.202207

I N F O

Corresponding Author:
Harsharan Kaur, State Institute of Health and Family Welfare, Parimahal, Kasumpti, Shimla, Himachal Pradesh, India.
E-mail Id:
dr.harsharankaur1962@gmail.com
Orcid Id:
https://orcid.org/0000-0001-8794-9144
How to cite this article:
Kaur H, Bharti OK. Matching Body Composition Confirms Decreased Phase Angle among Diabetics Compared to Controls. J Adv Res Med. 2022;9(3):1-6.

Date of Submission: 2022-08-21
Date of Acceptance: 2022-09-26

A B S T R A C T

Background: Diabetes Mellitus refers to a group of common metabolic disorders that depicts hyperglycemia. As per WHO, the number of people with diabetes rose from 108 million in 1980 to 422 million in 2014. The global prevalence of diabetes among adults over 18 years of age rose from 4.7% in 1980 to 8.5% in 2014. Simple screening can help detect diabetes early and save lives. Many studies have found decreased phase angle among diabetics than controls but since age and BMI can be the confounders, there are few studies to match these parameters to draw the right conclusions. The objective of study was to do a matched comparison of the body composition (Body Fat%, Lean Body Mass and Total Body Water, Intracellular and Extracellular Water %) and biochemical investigations of Diabetics and Non-Diabetic Controls.

Methods: The study population was taken from Indira G and hi Medical College, Shimla, which is one of the Tertiary care centers of Himachal Pradesh located in North India. All patients undergoing Body Composition measurements were diagnosed as diabetics on the basis of ADA (American Diabetic Association) diagnostic criteria. 60 diabetic patients fulfilling the inclusion criteria and 60 healthy age and sex-matched controls were enrolled in this study.

Results: Matched analysis was done and it was found that the Phase angle among diabetics was lower (5.6° + 0.9°) than controls (6.3° + 1.1°) and was statistically significant, p-value <0.005. A comparison of biochemical investigations shows that there was a statistically significant difference between diabetics and controls with respect to FBS, HbA1C, Cholesterol, VLDL and HDL.

Conclusion: Diabetics and controls were age, Sex and BMI matched with moderate physical activity. Waist Circumference (WC) was higher in diabetics indicating central obesity. The diabetics were found to be hypertensive with poor blood sugar control and dyslipidemia. The Phase Angle was decreased in diabetics than in controls, showing the prognosis of the disease.

Keywords: Phase Angle, Waist Circumference, Diabetes

Background

Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood sugar. Hyperglycemia, or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels. The global prevalence of diabetes among adults over 18 years of age rose from 4.7% in 1980 to 8.5% in 2014. In 2016, diabetes was the direct cause of 1.6 million deaths.[1]

The number of diabetics in India increased from 26·0 million in 1990 to 65·0 million in 2016. The prevalence of diabetes in adults aged 20 years or older in India increased from 5·5% in 1990 to 7·7% in 2016. The prevalence in 2016 was highest in Tamil Nadu, Kerala and Delhi followed by Punjab and Goa and Karnataka.[2] Epidemiological determinants of Diabetes are heredity, age, gender, sedentary lifestyle, obesity, low physical activity, unhealthy diet, access to alcohol, smoking and social factors like occupation, economic status, education, urbanization and change in lifestyle.[3]

Many studies have found decreased phase angle among diabetics than controls but since age and BMI can be the confounders[4], there are few studies to match these parameters to draw the right conclusions. The objective of study was to do a matched comparison of body composition (Body Fat%, Lean Body Mass and Total Body Water, Intracellular and Extracellular Water %) and Biochemical Investigations of Diabetics and Non-Diabetic Controls.

Materials and Method

Study Population

The patients visiting the Indira G and hi Medical College (IGMC) Shimla, a tertiary care center of Himachal Pradesh located in North India were included in the study.

Study Design

Sixty diabetic patients fulfilling inclusion criteria on the basis of ADA (American Diabetic Association) diagnostic criteria and 60 healthy age and sex-matched controls were enrolled in this study. Diabetics were defined based on their fasting plasma glucose >126mg/dl (after no calorie intake for at least 8 hours) or casual/r and om? plasma glucose >200mg/dl (taken at any time of day without regard to time of last meal) with classic symptoms of diabetes.

Among Controls 32 (53%) were males and 28 (47%) were females while among Diabetics 31 (52%) were males and 29 (48%) were females. Only those who consented for the study were enrolled.

Patients with Diabetes who had other comorbidities like COPD, Cancer, endocrine disorders (Cushing syndrome, acromegaly, glucagonoma and phaeochromocytoma), pancreatitis and renal failure and patients with associated complications of Diabetes like cardiovascular disease, retinopathy, neuropathy and nephropathy were excluded. Patients with amputation of the leg, had Pacemaker, edema, myocardial infarction and pyrexia and those who had any nutritional intervention, intensive exercise training or muscle strength training which could modulate body composition were also excluded.

Healthy Controls

Subjects with fasting plasma glucose value of 99mg/dl (ADA Criteria) as the upper limit of normal blood glucose. These subjects were selected from employees of IGMC, Shimla or from the attendants visiting the hospital along with patients.

All the parameters of the subjects with Diabetes disease were compared with normal healthy controls regarding age, sex.

Clinical Evaluation

All the eligible patients and subjects fulfilling the inclusion and exclusion criteria were subjected to detailed history pertaining to the disease. The demographic profile, physical activity and physical examination with anthropometrics and biochemical investigations were recorded in a predesigned structured questionnaire format.

Physical Examination

Systemic physical examination recorded including anthropometrics and blood pressure.

Ethical Clearance

The study was approved by Institutional Ethics Committee of IGMC Shimla.

Blood pressure, height, weight and waist and hip circumferences were measured using the standard techniques.

Physical Activity was assessed by using the International Physical Activity Questionnaire.

Biochemical Investigations

Each patient was subjected to estimation of Fasting Blood Sugar, Glycosylated Hemoglobin (HbA1c) and Lipid Profile after 8 hours of fasting state.

FBS and lipid profile were estimated by Konalab 30 fully automatic analyzer. HbA1c levels were estimated by using Nyco-Card Reader (Axis Shield) method. BODY COMPOSITION MEASUREMENT: Body Composition- was assessed by Multi-frequency bio-electrical impedance analysis (BODY STAT, QuadScan, 4000). BIA measurements were affected by meal, clothing and skin temperature and skin blood flows after exercise.[5]

ISSN: 2349-7181
DOI: https://doi.org/10.24321/2349.7181.202207

Guidelines were given to the patient before the procedure:

- Patients were advised not to eat meals for 4 hours before the test
- Patients were advised not to perform any exercise 12 hours prior to the test
- Patients were advised not to ingest coffee, tea, chocolate, or alcoholic beverages for 24 hours prior to the test
- Patients were advised to wear comfortable clothes

Preparation of the Patient for Measurement:

After taking the correct anthropometric measurement the patient was made to lie in a supine position with his/her socks and shoe removed with both arms and legs spread slightly and data was entered into the equipment. The local area was cleaned with spirit before the application of electrodes.

Placement of electrodes and leads-were on the dorsum of the right h and and dorsum of the right foot. Electrodes were self-adhesive and disposable. The leads were of two types, red leads and black leads. Red leads were the injecting leads and black leads were the measuring leads and these two leads were attached to the equipment. The electrodes were placed on the right h and on the dorsum by distal placement (behind the knuckles) and the red lead was attached to it and proximal placement (on the dorsum of the wrist joint) and black lead were attached to it. On the right foot, the electrodes were placed on the dorsum of the right foot by distal placement (behind the toes) and the red lead was attached to it, by proximal placement (on the ankle at the level and between the medial and lateral malleoli) and the black lead was attached to it. After the application of the electrodes and leads to the patient in the supine position for 3 to 5 minutes the enter button on the equipment was pressed for the measurement of body composition. In this study, the parameters will be measured as % body fat, Lean Body mass, total body water (Intracellular water % & Extracellular water %) and the various other components of the body with reactance & Phase Angle. The results were displayed on the screen of the equipment and recorded on the proforma.

All precautions such as no part of the body touching the other, that the patient/subjects were in a comfortable relaxed position before placing the electrodes after which body composition was measured on a non-conductive surface.

Statistical Analysis

The data was collected and summarized and analyzed separately for categorical and continuous variables using appropriate statistical analysis using SPSS version 11.0 and paired t-tests were used for comparative analysis. When the p-value was less than 0.5 the difference between the groups was considered statistically significant.

Results

Baseline Characteristics

The baseline characteristics were given in Table 1.

Table 1

Variables	Controls (N=60)	Diabetics (N=60)	P-Value
Age (years±SD)	47.58±9.94	50.46 ± 8.58	0.091*
Weight (kg±SD)	64.35±10.42	67.44 ± 11.71	0.128
Height (cm±SD)	160.83±11.15	160.38 ± 8.30	0.802
BMI (kg/m^2 ±SD)	25.04 ± 4.00	26.26 ± 4.38	0.115
WC (cm±SD)	88.78 ± 10.84	94.35 ± 10.76	0.005*
HC (cm±SD)	96.11 ±7.52	98.40 ± 9.09	0.135
WHR (cm±SD)	0.93 ± 0.06	1.21 ± 2.12	0.297
SBP (mm Hg)	123.16 ± 7.20	123.93 ± 12.46	0.680
DBP (mm Hg±SD)	78.56 ± 4.34	76.43 ± 6.57	0.038*

Age Distribution

The mean age of controls was 47.58 years + 9.94 years while that of diabetics was 50.46 years +8.58 years.

Weight (kg)

The mean weight of controls was 64.35 kg +10.42 kg while that of diabetics was 67.44 kg +11.71 kg with a p-value of 0.128, which is higher in diabetics than controls but statistically insignificant.

Height (cm)

Among the controls, the mean of their heights was 160.83 cm + 11.15 cm while among diabetics it was 160.38 cm +¬ 8.30 cm with the p-value calculated was 0.802 which indicated that the difference of means among both groups was not statistically significant.

Body Mass Index (BMI)

Among controls the mean of BMI was 25.04 weight/height2 + 4.00 weight/height2 while among the diabetics it was 26.26 weight/height2 + 4.38 weight/height2 with p-value 0.115. There wasn't any statistically significant difference observed in the mean BMI among the two groups.

ISSN: 2349-7181
DOI: https://doi.org/10.24321/2349.7181.202207

Waist Circumference (cm)

The mean of the Waist Circumference among controls was 88.78 cm + 10.84 cm while among diabetics was 94.35 cm +10.76 cm with p-value 0.005* which indicated the difference in means between diabetic and non-diabetic controls was statistically significant.

Hip Circumference (cm)

Hip Circumference among controls was 96.11 cm +7.52 cm while among diabetics was 98.40 cm +9.09 cm with p-value of 0.135 which indicated that the difference of means between both the groups was not statistically significant.

Waist Hip Ratio (WHR)

The waist/ Hip Ratio among controls was 0.93 cm + 0.06 cm while among diabetics was 1.21 cm + 2.12 cm with the p-value of 0.297 which indicated that the difference of means between both the groups was not statistically significant.

Blood Pressure

The mean Systolic Blood Pressure among Controls was 123.16 mm Hg + 7.20 mm Hg and for Diabetics was 123.93 mm Hg +12.46 mm Hg with a p-value of 0.680. The SBP in diabetics was slightly higher than that in controls but statistically insignificant.

The mean Diastolic Blood Pressure among controls was 78.56 mm Hg + 4.34 mm Hg while among diabetics it was 76.43 mm Hg +6.57 mm Hg with the p-value of 0.038* which showed that the DBP was higher in diabetics than in controls and was statistically significant.

Comparison of Physical Activity

Among the control group, 26 (43%) subjects had low, 31 (51%) subjects had moderate and 3 (6%) subjects had high physical activity. Among the diabetic group 28 (47%) patients had low, 28 (46%) patients had middle and 4 (7%) patients had high physical activity. The majority of the controls and diabetics had moderate physical activity.

Comparison of Biochemical Investigations (Table 2)

Fasting Blood Sugar (FBS)

The mean of Fasting Blood Sugar among the controls was 87.7 mg/dl+ 8.56 mg/dl while among the diabetics it was 157.49 mg/dl+60.24mg/dl with the p-value <0.001** which indicated that the difference of means between both the groups was statistically significant.

Glycosylated Haemoglobin (HbA1C)

The Glycosylated Haemoglobin (HbA1c) among the controls was 4.17 % + 0.48 % while among the diabetics it was 8.36 %+ 1.95 % with the p-value <0.001** which indicated that the difference of means between both the groups was statistically significant.

Table 2

Variables	Controls N=60	Diabetics N=60	P-Value
FBS (mg/dl)	87.7± 8.56	157.49±60.24	<0.001**
HbA1c (%)	4.17±0.48	7.36 ± 1.95	<0.001**
Triglycerides (mg/dl)	133.2± 82.91	164.6±69.53	0.027*
Cholesterol (mg/dl)	139.5± 34.68	174.6± 32.51	<0.001**
LDL (mg/dl)	79± 26.84	86.9 ± 33.48	0.156
VLDL (mg/dl)	24.92±9.32	39.35±17.53	<0.001**
HDL (mg/dl)	32.48± 14.72	45.3± 13.79	<0.001**

Triglycerides

The mean of Triglycerides among the controls was 133.2 mg/dl+ 82.91 mg/dl while among the diabetics it was 164.6 mg/dl+69.53 mg/dl with a p-value of 0.027* which indicated that the difference of means between both the groups was statistically significant.

Total Cholesterol

The mean of Cholesterol among the controls was 139.5 mg/dl+ 34.68 mg/dl while among the diabetics it was 174.6 mg/dl+ 32.51 mg/dl with the p-value <0.001**, which indicated that the difference of means between both the groups was statistically significant.

Low-Density Lipoprotein (LDL)

The mean of Low-Density Lipoproteins (LDL) among the controls was 79 mg/dl+ 26.84 mg/dl while among the diabetics it was 86.9 mg/dl+ 33.48 mg/dl with the p-value of 0.156 which indicated that the difference of means between both the groups was not statistically significant.

Very Low-Density Lipoprotein (Vldl)

The mean of Very Low-Density Lipoprotein (VLDL) among the controls was 24.92 mg/dl+9.32 mg/dl while among the diabetics was 39.35 mg/dl+17.53 mg/with the p-value <0.001** which indicated that the difference of means between both the group controls was statistically significant.

High-Density Lipoprotein (HDL)

The mean of High-Density Lipoproteins (HDL) among the controls was 32.48 mg/dl+ 14.72 mg/dl while among the diabetics was 45.3 mg/dl+ 13.79 mg/dl with the p-value <0.001** which indicated that the difference of means between both the groups was statistically significant.

ISSN: 2349-7181
DOI: https://doi.org/10.24321/2349.7181.202207

Comparison of Body Composition (Table 3)

Table 3

Variables	Controls n=60	Diabetics n=60	P-value
% Body Fat	34.16 + 7.30	33.15 +7.69	0.461
Lean Body Mass (Kg)	4.02 + 13.06	44.77 +9.45	0.720
Total Body Water %	50.51 +10.07	51.51 +7.45	0.540
Extracellular Water %	31.12+3.25	24.83 +8.81	0.151
Intracellular Water %	28.15 +5.04	28.31+ 5.74	0.875
Phase Angle°	6.3 + 1.1	5.6 + 0.9	0.005*

Percentage of Body Fat (%BF)

Percentage Body Fat among the controls was 34.16 % + 7.30 % while among the diabetics was 33.15 % +7.69 % with the p-value of 0.461which showed that % BF is lower in diabetics as compared to controls but statistically insignificant.

Lean Body Mass in Kg

Lean Body Mass (kg) among the controls was 44.02 Kg +13.06 kg while among the diabetics was 44.77 Kg +9.45 kg with a p-value of 0.720 which showed that Lean Body Mass is higher in diabetics than controls but statistically not significant.

Total Body Water Percentage (TBW %)

Total Body Water (TBW %) among controls was 50.51 % +10.07 % while among diabetics was 51.51 % +7.45 % with the p-value 0.540. This shows that the Total Body Water percentage in the diabetics is slightly higher than controls and was statistically insignificant.

Extracellular Water Percentage (ECW %)

Extra Cellular Water Percentage (ECW%) among controls was 31.12% +3.25 % while among diabetics it was 24.83 % +8.81 % with a p-value of 0.151 which showed that ECW% was higher in diabetics than in controls and was statistically insignificant.

Intracellular Water Percentage (ICW%)

Intra Cellular Water Percentage (ICW%) among the controls was 28.15 % +5.04 % while among diabetics was 28.31 % + 5.74 % with the p-value of 0.875 which showed that ICW% was almost equal but statistically not significant.

Phase Angle

The phase Angle among controls was 6.3° + 1.1° while among diabetics was 5.6° + 0.9° with a p-value of 0.005* which showed that the phase angle in diabetics was smaller than controls and statistically significant.

Discussion

Phase Angle (PhA) values have been found to be positively correlated with BMI[6] therefore it is important to do a matched analysis to underst and the importance of phase angle in diabetics. In our study, there was a statistically significant difference between matched diabetics and controls w.r.t. FBS, HbA1C and WC which is similar to a recent matched study from Korea[7]. PhA is not only important as a screening tool for Diabetes but also an important measure to check the nutritional status of the population[8] and body mass of players of different games[9]. Some studies suggest that the PhA could be used as a marker to reflect the nutritional status in patients with diabetic chronic kidney disease (DMCKD) [10]. Another study suggests that PhA could be an indicator for assessing the ability to control fasting blood glucose in T2DM patients in Korea as Statistically significant independent associations were observed between PhA with fasting blood glucose and HbA1c in T2DM.[11] Another study underlines that Phase angle values at 50 kHz decreased in people with diabetes and the changes were exacerbated as the disease duration increased. Thus, bioimpedance PhA values represent a non-invasive tool for monitoring the progression of diabetes mellitus.[12]

India has become the diabetic capital of the world and we need to put in place screening programmes to detect diabetes early. A study in India found that 62 % of newly diagnosedT2DM patients were having Metabolic Syndrome according to International Diabetes Federation (IDF) criteria.[13] Another study found the rate of metabolic syndrome to be 21 % in Uttrakh and , India and the younger population was most susceptible to metabolic derangements.[14] Another study underlines that a single value of the waist-to-height ratio (WHtR) irrespective of gender can be used as a universal screening tool for the identification of individuals at high risk of development of metabolic complications[15] and subsequent Diabetes.

Conclusion

Matching Body Composition confirms decreased Phase Angle among Diabetics compared to controls and phase angle values represent a noninvasive screening tool for detection and monitoring progress of diabetics in general populations.

Conflict of Interest: None

References

1. Diabetes - World Health Organization. Available from: https://www.who.int/news-room/fact-sheets/detail/

ISSN: 2349-7181
DOI: https://doi.org/10.24321/2349.7181.202207

diabetes.
2. India State-Level Disease Burden Initiative Diabetes Collaborators. The increasing burden of diabetes and variations among the states of India: the Global Burden of Disease Study 1990-2016. Lancet Glob Health. 2018 Dec;6(12):e1352-e62. [PubMed] [Google Scholar]
3. Chauhan A, Gupta M, Thakur J, Patro B, Bharti OK. Physical activity status and its determinants among public health care doctors in tertiary care public sector hospitals in Ch and igarh. IJAR. 2006;6(7):428-31. [Google Scholar]
4. Jun MH, Ku B, Kim J, Kim KH, Kim JU. Mediation effect of the duration of diabetes mellitus on the decrease in bioimpedance phase angles in ethnically Korean people: A multicenter clinical study. J Diabetes Investig. 2021 May;12(5):790-802. [PubMed] [Google Scholar]
5. BODY STAT, QuadScan, 4000. Available from: https://www.bodystat.com/product-catalog/quadscan-4000-touch-screen/.
6. Kumar S, Dutt A, Hemraj S, Bhat S, Manipadybhima B. Phase angle measurement in healthy human subjects through bio-impedance analysis. Iran J Basic Med Sci. 2012 Nov;15(6):1180-4. [PubMed] [Google Scholar]
7. Jun MH, Kim S, Ku B, Cho J, Kim K, Yoo HR, Kim JU. Glucose-independent segmental phase angles from multi-frequency bioimpedance analysis to discriminate diabetes mellitus. Sci Rep. 2018 Jan;8(1):648. [PubMed] [Google Scholar]
8. Tanaka S and o K, Kobayashi K, Seki T, Hamada T, Machino M, Ota K, Morozumi M, Kanbara S, Ito S, Ishiguro N, Hasegawa Y, Imagama S. Low bioelectrical impedance phase angle is a significant risk factor for frailty. Biomed Res Int. 2019 Jun;2019:6283153. [PubMed] [Google Scholar]
9. Di Vincenzo O, Marra M, Scalfi L. Bioelectrical impedance phase angle in sport: a systematic review. J Int Soc Sports Nutr. 2019 Nov;16(1):49. [PubMed] [Google Scholar]
10. Han BG, Lee JY, Kim JS, Yang JW. Decreased bioimpedance phase angle in patients with diabetic chronic kidney disease stage 5. Nutrients. 2019 Nov;11(12):2874. [PubMed] [Google Scholar]
11. Choi HN, Kim KA, Kim YS, Yim JE. Independent association of phase angle with fasting blood glucose and hemoglobin A1c in Korean type 2 diabetes patients. ClinNutr Res. 2020;9(3):205-212. [PubMed] [Google Scholar]
12. Jun MH, Ku B, Kim J, Kim KH, Kim JU. Mediation effect of the duration of diabetes mellitus on the decrease in bioimpedance phase angles in ethnically Korean people: A multicenter clinical study. J Diabetes Investig. 2021 May;12(5):790-802. [PubMed] [Google Scholar]
13. Dhanaraj E, Bhansali A, Jaggi S, Dutta P, Jain S, Tiwari P, Ramarao P. Predictors of metabolic syndrome in Asian north Indians with newly detected type 2 diabetes. Indian J Med Res. 2009 May;129(5):506-14. [PubMed] [Google Scholar]
14. Goyal R, Kumar A, Singhai M. Study of metabolic syndrome and its risk components in patients attending tertiary care center of Uttarakh and . Indian J Clin Biochem. 2014 Jul;29(3):362-6. [PubMed] [Google Scholar]
15. Verma M, Rajput M, Sahoo SS, Kaur N, Rohilla R. Correlation between the percentage of body fat and surrogate indices of obesity among adult population in rural block of Haryana. J Family Med Prim Care. 2016 Jan-Mar;5(1):154-9. [PubMed] [Google Scholar]

ISSN: 2349-7181
DOI: https://doi.org/10.24321/2349.7181.202207