Original Article

Exploring Anthropometrics, Body Composition and Antioxidant Capacity in Prediabetic Population with and without Family History of Diabetes

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ABSTRACT

Objective: To explore the anthropometric measurements, body composition, individual and total antioxidant capacity in prediabetic Pakistani population with and without family history of diabetes.

Study Design: Experimental study

Place and Duration of Study: This study was conducted at the department of Physiology, Institute of Basic Medical Sciences, Khyber Medical University, Peshawar, Pakistan between February 2019 to January 2020.

Materials and Methods: Prediabetics (n=50), 18 to 35years age group, were included in the study, 25 participants in positive and negative family history of diabetes. All those participants with HbA1c in the limit of 5.7– 6.4%, and fasting blood glucose (FBG) between 100 to 126 mg/dL were included the study. The anthropometric measurements including body weight, height, waist and hip circumference, waist hip ratio, BMI, fat mass and body fat% were measured. The fasting blood samples were examined for total and individual antioxidant capacity by sandwich Enzyme Linked Immunosorbent Assay (ELISA).

Results: The weight, waist and hip circumference, waist/hip ratio, body mass index, fat mass and body fat% were different in family history positive and negative groups. The mean levels of superoxide dismutase, glutathione peroxidase, Uric acid ($p < 0.006$), Vitamin C, nitric oxide ($p = 0.022$) and total antioxidant capacity were higher in negative compared to positive family history group.

Conclusion: The anthropometric measurements, individual and total antioxidant capacity were different in prediabetic population with positive and negative family history of diabetes.

Key Words: Prediabetes, family history, anthropometry, body composition and antioxidant capacity

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INTRODUCTION

Prediabetes (PD) is a state of hyperglycemia defined by glycemic indices below the level for diabetes[1]. Prediabetes prevalence is on the rise globally and it has been estimated that more than 470 million population will develop PD by the year 2030[1,2]. The prevalence of PD is quite high in Pakistan.

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A survey done in 2018, 14% population had PD in Pakistan being higher in urban population in comparison to rural[3]. The prevalence of type 2 diabetes mellitus (T2DM) across Pakistan was 16.98% and prediabetes was 10.91% across Pakistan according to a survey done by Aamir et al., 2018[1]. Family history (FH) of diabetes especially first-degree relatives (parents and siblings), obesity, sedentary lifestyle, and dyslipidemia are a risk factors for PD and diabetes.

Prediabetes is associated with β cell dysfunction, insulin resistance, increased lipolysis, inflammation, micro and macrovascular complications[4]. The individuals with hyperglycemia in prediabetic stage develop diabetes that is more problematic and difficult to manage[5]. The dyslipidemia, obesity, sedentary lifestyle and low total antioxidant capacity, was reported in prediabetics compared to those with normal glucose level[6].

In addition, individuals who have diabetes have higher serum uric acid concentration than non-diabetic population[7]. Oxidative stress due to high blood glucose level occurs in PD and diabetes and influences the antioxidant capacity[8]. The antioxidant capacity may be affected, and compromised defense can lead to tissue

injury. The antioxidants can be categorized in two categories; enzymatic and non-enzymatic that can neutralize the reactive oxygen species (ROS). The enzymatic antioxidants include 'superoxide dismutase (SOD) and glutathione peroxidase (GPx)', while the non-enzymatic classification have nitric oxide (NO), uric acid (UA), and vitamins like C and E[9].

At present there are no concrete clinical guidelines for management of PD. It is the need of the day to explore the differences in anthropometrics, body composition and antioxidant capacity of the groups with positive FH of diabetes or no FH at baseline for better understanding of the pathophysiological processes and design programs for lifestyle modifications to prevent the development of prediabetes.

MATERIALS AND METHODS

It was an experimental study with purposive sampling. Anthropometric parameters, diabetic profile, and antioxidant capacity was compared between positive and negative FH groups in Pakistani prediabetic population. All the participants, 18 to 35 years of age (n=50); with FH of T2DM in first degree relatives were included in the study. All lab work was carried out from 1st February 2019 to 4th January 2020 in the Department of Physiology, Institute of Basic Medical Sciences, Khyber Medical University, Peshawar, Pakistan. Ethical approval was obtained from the Ethical review committee of Khyber Medical University under DIR/KMU-EB/BP/000580 dated 09/04/2019 and all the experimental work and procedures were done in accord with the Declaration of Helsinki 1964. Prediabetic volunteers were excluded from the study who had history of smoking, sleep disorders, acute or chronic health problems and on antioxidant supplementation. Recruited participants had FBG between 100 -125 mg/dL and HbA1c between 5.7 - 6.4% in accordance with the guidelines of American Diabetes Association[10]. Informed consent was obtained from each participant.

The sample size was calculated using G Power 3.1.9.2. TAC values from Rodriguez et al., 2017 Mohieldein et al., 2015, were used for sample size calculation[11]. The power of 0.95 and $\alpha = 0.05$, the calculated sample size was 26 in the first study and sample size 10 in the second study respectively [6]. We recruited 50 prediabetic participants in the study, 25 with positive FH and 25 with negative FH of diabetes. Their anthropometric measurements and body composition using Xiaomi Mi Scale were determined. Blood samples were taken in fasting state after 48h restriction of high antioxidant diet and analysis was done for diabetic profile and antioxidant capacity by Sandwich ELISA. The antioxidants examined were superoxide dismutase (SOD), glutathione peroxidase (GPx), nitric oxide (NO) Vitamin C, with assay kits from Bioassay Technology Laboratory, Shanghai, China. Uric acid was measured by DIALAB Production, Austria and total antioxidant capacity measured by Ferric Reducing Antioxidant Power Assay (FRAP) using Colorimetric Assay kit by Elabscience USA.

RESULTS

The results were compared between the two FH groups: positive and negative. Positive FH group had a higher weight, body mass index (BMI), waist and hip circumference, body fat, fat mass and lean mass.

Table No.1: Anthropometric measurements in positive and Negative Family history groups in Prediabetic Population.

Group Statistics	Family Hx Positive Mean ± SD	Family Hx Negative Mean ± SD	P value
Age (y)	30 ± 4.7	28 ± 5	0.157
Ht (cm)	162 ± 9	167 ± 7	0.030
Wt (kg)	76 ± 15	73 ± 13	0.354
WC (cm)	96 ± 12	91.8 ± 10	0.05
HC (cm)	105 ± 10	100 ± 6.7	0.042
BMI (%)	29 ± 5	26 ± 3.29	0.007
BF (%)	36 ± 7	27.7 ± 6.1	0.001
FM (kg)	26 ± 9	20.21 ± 5.94	0.006
LM (kg)	47.5 ± 12	52.4 ± 9.6	0.118
FBG (mg/dL)	110 ± 7	110 ± 6.4	0.884
HbA1c (%)	6 ± 0.25	6 ± 0.23	0.954
Insulin (µIU/ml)	20 ± 12.4	14 ± 9.5	0.057
Insulin Resistance	5.48 ± 3.5	3.78 ± 2.6	0.059

Ht = height, Wt = weight, WC = waist circumference, HC = hip circumference, WHR = waist-hip ratio, BMI = body mass index, BF = body fat, FM = fat mass, LM = lean mass, FBG = fasting blood glucose, HbA1c = glycated hemoglobin. Independent t test was applied. $P \leq 0.05$ was considered as statistically significant.

Table No.2: Antioxidant level in Prediabetics with Positive and Negative Family History of Diabetes.

Antioxidants	Family Hx Positive Mean ± SD	Family Hx Negative Mean ± SD	P value
SOD U/ml	176 ± 105	229 ± 153	0.168
GPx ng/ml	49.6 ± 45	53.6 ± 45	0.761
UA mg/dL	4.5 ± 1	5 ± 0.8	0.006
VitC ng/ml	71 ± 75.5	96 ± 84.5	0.284
NO mIU/ml	168 ± 136	289.2 ± 210	0.022
TAC µg/ml	0.76 ± 0.2	0.79 ± 0.16	0.559

SOD = superoxide dismutase, GPx = glutathione peroxidase, NO = nitric oxide, VitC = Vitamin C, UA = uric acid and TAC = total antioxidant capacity. Independent sample t test was applied. P $\leq$ 0.05 was considered as statistically significant.

A statistically significant difference between the two groups was observed with BMI, hip circumference, body fat and fat mass. The mean FBG, HbA1c, insulin level and insulin resistance were also greater in positive FH group in comparison to no FH of diabetes as in Table 1. The antioxidants SOD, GPx, uric acid, Vit C, nitric oxide, and TAC were greater in negative FH group showing a much better antioxidant defense in those with no FH of diabetes. Uric acid and nitric oxide levels showed statistically significant difference between the two groups being higher in negative family history group as in table 2.

DISCUSSION

The prediabetic participants with FH of diabetes had higher anthropometric measurements and lower antioxidant levels in comparison to those with no FH of diabetes. FBG and HbA1c levels in the two groups in our population were similar in both prediabetic groups. The mean BMI, weight, WC, HC, fat mass and body fat was higher in positive FH group in comparison to negative FH group, but statistically significant increase was observed only for BMI, WC, HC, body fat%, fat mass between participants with positive and negative FH. Participants with positive FH were shorter, older, and heavier and exhibited more features of android obesity as shown in table 1. These differences in body composition based on family history are supported by Wang et al., 2020[12]. Similarly, another study reported individuals with family history of diabetes with greater body fat% and lower lean mass than control supporting our findings[13]. FH of diabetes has evolved as a risk factor for diabetes and can be attributed to genetic component and environmental factors[14,2]. Prediabetes has a causal relationship with obesity, physical inactivity and diminished total antioxidant capacity as compared to normoglycemic individuals and is consistent with our findings[11]. The cardinal signs of T2DM are insulin resistance and malfunction of the beta cells of pancreas[15,16]. This is consistent with our findings: greater insulin resistance in positive FH group of diabetes.

Literature search shows limited work done on redox status in prediabetic population and the conclusions reached so far are controversial. The pathogenesis of PD and diabetes with deranged FBG involves oxidative stress. ROS generated during this leads to cellular injury and are detoxified by the antioxidants[17]. TAC reflects the endogenous and exogenous antioxidants in plasma and is represented by uric acid, ascorbic acid, and proteins[18]. A study done in elderly prediabetic population showed diminished SOD and TAC levels compared to control group and is consistent with our findings[18]. Serum uric acid levels were found to be lower in prediabetic population than normal[19]. In addition, lower uric acid level was observed in prediabetics with positive family history in our study population. Uric acid, an important antioxidant in plasma, shields against ROS[20]. It can therefore be postulated that lower uric acid levels in PD can be because of high oxidative stress and family history of diabetes is a risk factor for T2DM[21]. Vitamin C and nitric oxide levels were also found to be lower in diabetic population as compared to normoglycemic population consistent with our findings[22,23]. Moreover, it has been determined that siblings of diabetics have elevated insulin levels and are predisposed to develop PD and diabetes if not aware of it, so early screening and prevention is recommended[23]. Furthermore, first degree relatives of patients with DM demonstrated a greater risk of developing PD coupled with malfunction of endothelium and beta cells, IR and abnormal glucose metabolism[24].

CONCLUSION

The results of the study show higher weight, waist, hip circumference, BMI, and lower individual and total antioxidant capacity in prediabetic positive family history group than in prediabetic population with no family history of diabetes. So, it is concluded that family history is a risk factor for the development of prediabetes and diabetes mellitus.

Recommendations: Screening of population should be done for prediabetes and diabetes. Antioxidant supplements should be taken by individual with prediabetes especially those with family history of diabetes.

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Author's Contribution:

Concept & Design of Study:	Zubia Shah
Drafting:	Inayat Shah
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Revisiting Critically:	Zubia Shah, Inayat Shah
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Conflict of Interest: The study has no conflict of interest to declare by any author.

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