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Anthropometric indices as an indicator for metabolic disorders in individuals with Diabetes mellitus

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Abstract

Diabetes mellitus is a disease of disturbed metabolism which results in abnormal blood sugar levels. The aim of the study was to investigate the association of various anthropometric parameters with diabetes. An observational study was conducted on 187 cases and 182 controls from Malwa region of Punjab. Anthropometric measurements were taken and BMI as well as WHR was calculated. The risk of metabolic complications was assessed on the basis of significance of Chi square ($p < 0.05$). More subjects were at higher health risk in case males as compared to females on the basis of WHR with statistically significant differences. All the anthropometric parameters were greater in both case and control males as compared to females with statistically significant differences whereas the female cases had greater BMI values than males. Males were found to be more prone to metabolic problems in both cases and controls due to greater WC and WHR.

Type 2 diabetes is a chronic disease which causes blood glucose level to build up in body either due to insulin resistance or defect in insulin action, due to which the cells are not able to utilize blood glucose efficiently[17]. The severity of the symptoms may vary person to person according to type and duration of suffering.[12] According to International Diabetes Federation[10], 425 million individuals have been diagnosed with diabetes, which may increase upto 629 million in 2040. India is second highest diabetes prevalent country with 72.9 million people suffering from this condition followed by China (114.4)[10]. In Punjab[19], the prevalence of diabetes was found to be 9.8% in 2016. Obesity is the major factor because when fat gets deposited in tissues, it resists the cell to use insulin. If the fat is accumulated in abdominal region, then the risk of occurrence of type 2 diabetes is more than if the fat is deposited at

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the upper or lower region of the body. Unfortunately, its prevalence is increasing among children and young adults.[1] Further research is required on type 2 diabetes which may reduce the risk factors and various other health complications associated with it. The aim of the present study was to investigate the association of various anthropometric parameters *i.e*. weight, height, body mass index, waist circumference, hip circumference and waist to hip ratio in cases and controls and to evaluate sexual dimorphism in these parameters.

Population study : The study was conducted in Malwa region of Punjab from November 2017 to June 2018. A case control study was conducted on 369 subjects including 187 cases with type 2 diabetes mellitus (92 females and 94 males) and 182 controls *i.e*, non-diabetic (82 females and 100 males). The subjects with major problems like nephropathy, retinopathy, cardiovascular problems, pregnant women and wheel chair bounded individuals were excluded from the study.

Data Collection and Anthropometric measurements: A structured information sheet was prepared to collect the data from the participants. An Institutional approval was obtained from Institutional Ethical Committee, Punjabi University, Patiala (IEC No. 54). Data has been collected by face to face interview using non-probability purposive sampling method. A detained personal information was collected including gender, age, residence, education and physical examination was done after getting a written consent from them. The anthropometric measurements (Weight, Height, WC and HC) were taken by the trained investigators and further, the collected data was checked by the corresponding author. Body weight was measured in kilograms by using Electronic Weighing Machine and standing height was measured by using anthropometric rod in centimeters. The waist circumference was measured with steel tape from a level midway between lower rib margin and iliac crest whereas hip circumference was measured as maximal circumference over the buttocks all around the body in horizontal position. Body Mass Index (BMI) was calculated as weight in kilograms divided by the square of the body height in meters. Waist-Hip Ratio (WHR) was also calculated by dividing waist circumference to hip circumference in centimeters.

Statistical Analysis: The categorization of individuals on the basis of BMI, WC and WHR was done according to the criteria given by WHO (2008). BMI (<18.50= underweight, ≥ 25.00 overweight, ≥30.00 obese), WHR (≥0.90 for males and ≥0.85 for females) and WC (≥102 for males and ≥0.88 for females) were used to measure central obesity with respect to increase in risk of metabolic complications. SPSS software version 16.6 was used to perform statistical analysis of data. The significant mean difference was calculated using student t-test in cases v/s controls and males v/s females with statistical significance at $p<0.05$. Correlation of continuous variables was also assessed. The risk of metabolic complications was assessed on the basis of significance of Chi square ($p <0.05$).

The mean age of T2DM males was higher than mean age of females with T2DM and the mean ± standard deviation of control

males (51.83 cm and 8.61 cm respectively) were higher than control females (50.23 cm and 7.46 cm respectively) (Table-1). Both affected (77.85kg) and unaffected males (76.63kg) were heavier in comparison to case (70.32kg) and control (69.50kg) females with statistically significant differences between the two sexes in both the studied groups. Males in both groups (cases and controls) were taller than females and differences were found to be statistically significant. Male cases had greater waist circumference (104.46cm) than females (100.20cm) with statistically significant differences (2.56). The hip circumference values were similar for both the gender in cases (102.95 and 102.15 respectively) as well as control males and females (99.62 and 100.62 respectively) with statistically non-significant differences whereas the mean hip circumference was greater in cases than controls. The t-value was found to be statistically significant for waist-hip ratio among cases (males and females) with t-value of 3.64 and in controls (males and females) with the value of 2.97. Weight, height, waist circumference and waist-hip ratio were higher in both case and control males as compared to their female peers with statistically significant differences whereas the female cases had greater BMI than males.

The frequency of subjects with Body Mass Index > 25.00 kg/m² (over-weight) was higher in female cases as compared to male cases (*i.e* 69 and 64 respectively) with statistically non-significant chi- square value of 2.74 whereas more number of male controls were over-weight (62) than their female counterparts (53) (Table no. 2). The frequency of obese individuals for both sexes was similar in both cases and controls. On the basis of waist circumference, greater percentage of males (both cases and controls) had increased and substantially increased risk of metabolic complications than females with statistically significant differences only for cases. Greater frequency of subjects on the basis of Waist-Hip Ratio was observed in the category of higher health risk in case males (93) as compared to females (84) with statistically significant differences (chi-square value 6.85). Therefore, males were found to be more prone to metabolic problems in both cases and controls with statistically significant differences with respect to cases.

Table-1. Sexual dimorphism in anthropometric variables among cases and controls

Variable	Cases		t- value	Controls		t- value
	Mean ±SD			Mean ±SD		
	Males	Females		Males	Females	
Age (years)	56.46±9.07	55.09 ±8.78	1.05	51.83±8.61	50.23 ±7.46	1.34
Weight (kg)	77.85±11.46	70.32 ±11.07	4.56***	76.63±13.54	69.50±11.58	3.82***
Height (m)	1.71±0.06	1.60 ±0.07	10.84***	1.71 ±0.07	1.62 ±0.06	7.78***
BMI (kg/m²)	26.47±3.52	27.29 ±3.24	1.60	26.01 ±3.74	26.09 ±3.32	0.16
WC(cm)	104.46±11.34	100.20±11.32	2.56**	97.54±10.63	95.98±10.57	0.98
HC (cm)	102.95±8.69	102.15±9.77	0.58	99.62 ±9.27	100.62±10.94	0.65
WHR	1.01±0.05	0.98 ±0.66	3.64***	0.97 ±0.05	0.95 ±0.05	2.97**

** Statistically significant p<0.01

*** Statistically significant p<0.001

Table-2. Categorization of individuals on the basis of BMI, WC and WHR (acc. To WHO, 2008).

Classification	Cut-off values	Cases		Chi-square value	Controls		Chi-square value
		Frequency			Frequency		
		Males N (%)	Females N (%)		Males N (%)	Females N (%)	
Body Mass Index –BMI							
Under weight	<18.50	2 (2.12)	1(1.07)	2.74	3(3)	1(1.21)	4.04
Normal	18.5-24.99	28(29.78)	23(24.73)		35(350	28(34.1)	
Over-weight	**≥25.00**	**64(68.08)**	**69(74.19)**		**62(62)**	**53(64.6)**	
Pre-obese	25.00-29.99	50(53.19)	49(52.68)		44(44)	43(52.4)	
Obese	**≥30.00**	**14(14.89)**	**20(21.50)**		**18(18)**	**10(12.1)**	
Waist Circumference- WC (Risk of metabolic complications)							
Low	M <94F <70.99	14(14.98)	27(29.03)	7.28*	34(34)	34(41.4)	2.58
Increased	M= 94-101.99 F >80	23(23.46)	26(27.95)		28(28)	26(31.7)	
Substantially increased	M e 102F >88	57(60.63)	40(43.01)		38(38)	22(26.8)	
Waist-Hip Ratio –WHR (Risk of metabolic complications)							
Low	M ≤0.89F ≤0.84	1(1.06)	9(9.96)	6.85**	5(5)	10(12.1)	3.084
Higher	M ≥0.90F ≥0.85	93(98.93)	84(90.32)		95(95)	72(87.8)	

* Statistically significant $p<0.05$

** Statistically significant $p<0.01$

Weight showed a highly significant relationship with height, BMI, WC, HC and WHR for male and female cases in (Table-3). BMI and WC were also observed to be correlated with WC, HC and WHR while other relationships were statistically non-significant. On the other hand, the correlation of age and WHR was non-significant with any of the variables in controls.

To assess the prevalence of obese and overweight populations, body mass index and waist to hip ratio calculation is a simplest method.[4] Increase in weight, BMI and WHR is a significant indicator of T2DM and obesity.[7]

The findings of the present study concluded the association of Type 2 diabetes with various anthropometric variables (weight, BMI, HC, WC and WHR). Among these, waist circumference showed greater differences in both male and female cases than their control counterparts as compared to other anthropometric measures. Insulin resistance had also been found to be associated by visceral fat by Duman *et al*.[5] as it secretes adipokines that leads to impaired glucose tolerance. Jia *et al*.[11] reported WC to be the best indicator of type 2 diabetes followed by BMI and WHR.[11] The current study observed that 68.08% of the total diabetic

Table-3. Correlation between the different parameters in cases and controls

Variables			Age (years)	Weight (kg)	Height (m)	BMI (kg/m^2)	WC (cm)	HC (cm)	WHR
Age (years)	Cases	Males	1	0.01	0.10	0.03	0.13	0.02	0.22*
		Females	1	0.11	0.21*	0.003	0.14	0.11	0.05
	Controls	Males	1	0.08	0.08	0.04	0.02	0.01	0.03
		Females	1	0.03	0.15	0.054	0.07	0.004	0.13
Weight (kg)	Cases	Males		1	0.38**	0.87**	0.65**	0.64**	0.31**
		Females		1	0.65**	0.79**	0.50**	0.48**	0.16
	Controls	Males		1	0.57**	0.86**	0.66**	0.73**	0.05
		Females		1	0.70**	0.88**	0.59**	0.49**	0.25*
Height (m)	Cases	Males			1	0.09	0.03	0.11	0.12
		Females			1	0.07	0.21*	0.25*	0.007
	Controls	Males			1	0.10	0.13	0.30**	0.25*
		Females			1	0.31**	0.34**	0.25*	0.21
BMI (kg/m^2)	Cases	Males				1	0.69**	0.63**	0.40**
		Females				1	0.52**	0.47**	0.21*
	Controls	Males				1	0.72**	0.71**	0.22*
		Females				1	0.59**	0.51**	0.21*
WC (cm)	Cases	Males					1	0.87**	0.64**
		Females					1	0.80**	0.52**
	Controls	Males					1	0.85**	0.51**
		Females					1	0.88**	0.24*
HC (cm)	Cases	Males						1	0.20*
		Females						1	0.08
	Controls	Males						1	0.004
		Females						1	0.23*
WHR	Cases	Males							1
		Females							1
	Controls	Males							1
		Females							1

* Statistically significant $p<0.05$

** Statistically significant $p<0.01$

*** Statistically significant $p<0.001$

male individuals were over-weight. Whereas, in the earlier study conducted among diabetic males by Nakagami *et al.*[15], it was observed that 49% of Indians and 53% of the European population were overweight.[15] Sergeant *et al.* (2012) found mean value of waist circumference to be 80.3±11.6 in males and 82.6±12.7 in females (with p= 0.009) and differences were statistically significant.[18] Picca *et al.*[16] could not find any prediction of glycemic level by assessing the anthropometric parameters in type 2 diabetic males and females.[16] While

comparing cases with controls in the present study, it was observed that the percentage of over-weight individuals was more in type 2 diabetic sufferers in both males and females *i.e.* 68.08% and 74.19% respectively as compared to controls (62% in males and 64.63% in females). Mohammad *et al.* (2014) observed that mean value of waist circumference was 99.59±9.68 cm in the diabetic population (males) of Iran,[13] which is similar to the present study, while Gokhale *et al.* (2017) found value to be 94.76±9.8cm in Indian diabetic males of Maharashtra.[6] The mean WC values were higher in diabetic population (both males and females) than their control counterparts in a case-control study conducted in Guadeloupean population[4] as well as greater mean values in type 2 diabetic patients for both sexes in Iranian population.[7]

A similar pattern was observed in South Indian population with 27.5% overweight individuals in cases and 15.7% in healthy individuals which were statistically significant (p= 0.02).[2] The significant associations were also detected between anthropometric parameters including BMI, WC with the incidence of risk of type 2 diabetes.[20] The males were heavier and had greater WC and WHR for both cases and controls as compared to females in the study conducted by Han *et al.*[8]. These trends were similar to the results of current study.

The percentage of type 2 diabetic subjects was higher in high health risk category in males (98.93%) than females (90.32%) (chi- square= 6.85, p= 0.009) in the present subjects. Whereas, the percentage was found to be less in both male and female controls. While comparing both the sexes, it was observed that greater percentage of males had higher health risks than females. Awasthi *et al.* (2017) observed that 82.4% of the cases had higher risk of metabolic complications on the basis of WHR and 80.4% of controls (chi-square= 0.06, p= 0.79), which was not statistically significant in South Indian population.[2] The variation was due to regional differences and changes in their dietary habits. There were inverse findings for mean BMI as the prevalence was higher in diabetic females[3] in comparison to males but WC was higher in males, showing similar results as in the current study.

The correlation of HC with BMI, WC, height and weight was observed among cases and controlsin Spain population.[9] and WHR was also correlated to WC with highly significant differences (p= 0.001) in the population from Tamali, Ghana.[14] According to the current study, height, BMI and WC showed highly significant correlation with all of the anthropometric variables. The values for correlation of weight, BMI and WC were statistically significant while HC was only correlated with WHR in control females. The present study concluded that the males are heavier in both case and control males as compared to females with statistically significant differences whereas the female cases had greater BMI than males. Males were found to be more prone to metabolic problems in both cases and controls due to greater WC and WHR. A correlation was observed for weight with height, BMI, WC, HC and WHR for male and female cases.

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