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Status of T2D In Punjabi Indian Females Based on Risk Variable Factor Analysis

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Abstract

Problem Statement: Obesity, hypertension and glucose levels have been associated with the risk of T2D development. Body Mass Index (BMI), Waist-Hip Ratio (WHR) are the indicators of obesity, Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) are the indicators of hypertenion and fasting blood sugar (FBS) and Random blood sugar (RBS) are the indicators for glucose levels. Independent association of these markers with T2D has been reported earlier but no information is available on the association of T2D employing Principal Component Factor Analysis (PCFA) in North Indian population. Present study is an attempt to assess the influence of these diverse parameters in multi ethnic cohort of North Indian Punjabi females.

Approach: The study included a total of 492 females (242 diabetic cases and 250 healthy controls) belonging to Punjabi population. Following literature survey, proforma was designed to accommodate required anthropometric and physiometric parameters. PCFA was used to extract orthogonal factors from anthropometric and physiometric variables.

Results: PCFA of 9 interrelated risk parameters, extracted 5 main factors (SBP, DBP, FBS, RBS, BMI and WHR) associated with increased risk of T2D in diabetic Punjabi females. The analysis also revealed that, these factors can independently act as risk predictors in diabetics as compared to non diabetics.

Conclusion: Based on the data, we construe that blood pressure and glucose levels are the most significantly parameter associated with increased the risk of T2D in Punjabi females.

Keywords: Type 2 Diabetes, Hypertension, Age, PCFA, Obesity, FBS

Introduction

Prevalence of T2D is rising at an alarming rate proving to be a threat for both developing and developed countries [1,2]. It has been estimated that by the year 2030, 366 million people worldwide will be affected from diabetes mellitus and among them 79.4 million will be Indians[3]. This steep rise in T2D endemic in India may be due to population growth and ageing [3].

T2D represents a heterogeneous group of disorders characterised by complex interaction amongst genetic variants, environmental factors like obesity, hypertension and physical activity. The correlation between increased body fat

and T2D has been demonstrated by several studies [4-7]. For ever growing menace of T2D, obesity and hypertension have been recognized as the primary risk factors [8,9]. To assess the central and overall obesity, WHR and BMI both have been used as indicators for association analysis. Several studies have conducted for both independent and combined association of BMI and WHR with T2D amongst different populations [10,11]. This relationship has been investigated in Indian population also [12]. Similarly, hypertension has also been associated as risk factor with T2D development. SBP, DBP and MBP are the physiomatric measures for hypertension. FBS and RBS are the indicators of elevated glucose levels used to assess diabetic and non diabetic status in individuals. Independent association of these indicators (BMI, WHR, SBP, DBP, DBP, FBS and RBS) as risk factors for T2D have been previously reported but no study was conducted shoiwng association using Principle Componenet Factor Analysis in North Indian population. PCFA provides estimate about the factora that are linked with highest risk encompassing maximum variance and coverage. PCFA also determines the risk factors that require higher attention in combination with other factors predisposing Punjabi females towards greater risk of T2D development. Present study deals with the assessment of these diverse parameters in multi ethnic cohort of North Indian Punjabi females to establish strong association of most predominant factor with T2D.

Materials and Methods

Study Design, Questionnaire and Participants

The study included a total of 492 Punjabi females (242 cases and 250 controls) belonging to multiple ethnicities and samples were collected from Amritsar and adjoining regions. Questionnaire was designed after thorough screening of the literature. Female subjects were diagnosed with T2D by the clinicians were randomly selected for the study and then informed written consent was obtained from them. The study was approved by Guru Nanak Dev University Ethical Committee. All the information regarding the full name with surname of the participant, information about the caste and sub caste, family background, socio economic status, family history and other demographic variables was carefully recorded. Dietary pattern of the participants was also evaluated by ascertaining their food choices.

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Age and ethnicity matched females with no history of T2D, no associated disorder like hypertension, cancer or any other infectious disease were taken as controls. Parameters such as age, BMI, WHR, SBP, DBP, fasting and random glucose levels and dietary pattern were included in controls.

Anthropometric Measurements

Anthropometric measurements like height (in m), weight (in kg), waist circumference (in cm) and hip circumference (in cm) were taken accurately using standard protocol. WHR was calculated by dividing waist circumference with hip circumference. The cut off for WHR was taken as 0.81 for females to define central obesity [13]. BMI was calculated as weight (in kg) divided by height squared (wt/ht^2). The cut off value for BMI was taken as ≥ 23 [14]. All the anthropometric measurements were taken using standard techniques [15,16].

Assessment of Physiometric Measurements

The patients with a history of antihypertensive medication or Systolic Blood Pressure (SBP) of ≥140 mmHg and Diastolic Blood Pressure (DBP) of ≥90 mmHg were taken to be clinically hypertensive. The readings were taken by standard mercury sphygmomanometer according to American Heart Association (AHA, 1981). Using the values of SBP and DBP, mean Arterial Blood Pressure (MBP) and pulse pressure (PP) were also calculated [17].

Statistical Analysis

All the statistical analysis was carried out using Statistical Package for Social Science Program (SPSS version 17.0; SPSS Chicago, IL). Principal Component Factor Analysis (PCFA) was used to extract orthogonal factors from anthropometric and physiomatric variables. This statistical tool was able to reduce a large number of inter-correlated variables to a smaller number of principal components which accounts most of the variance in the data. The components with eigenvalue greater or equal to 1 were retained for the analysis. The correlations between the factors were explained by factor loading which were considered greater than or equal to 0.4 for the significant contribution of an original variables to factors. A p value <0.05 (two-tailed) was considered as significant.

Results

Nine interlinked risk factors (Age, BMI, WHR, SBP, DBP, MBP, PP, FBS and RBS) were subjected to PCFA. We confirm PCFA with orthogonal rotation reduced nine inter correlated variables into the groups of uncorrelated factors. The results of the analysis have been compared between control and diabetic subjects. To date no such study with PCFA of quantitative risk factors assessment for T2D has been available from the Punjabi population. Descriptive statistics for all the studied variable among controls and type 2 diabetics are presented in Table 1. The data used in this study consisted of 250 controls and 242 diabetics. The mean age of both the controls and cases were 47.23 ± 9.07 and 54.12 ± 10.35 years, respectively. However the onset of T2D among cases is 47.17 ± 9.64 years. All the studied phenotypes such as age, BMI, WHR, SBP, MBP, FBS, RBS and PP were found to be significantly higher <0.001 among the cases studied. All the values of mean differences (control-cases) were found to be negative indicating that control group has reduced values.

Pearson's correlations among eight normally distributed variables are presented in Table 2. The upper triangle corresponds to diabetic subjects and lower triangle refers to control subjects. In both groups, strong correlation was observed with SBP, DBP, BMI, PP and glucose concentration. Almost all the important variables are significantly inter-correlated among both cases and controls which demonstrated complex structure of factors.

The detailed characteristics of PCFA analysis is presented in the Table 3. The analysis extracted five factors for diabetic cases and four for controls. This reflects nearly 65% and 72% of the total variance of the nine original risk traits for T2D and controls, respectively. Factor one (SBP, DBP and PP) is common for both diabetics and controls. It has the maximum loading of traits which may reflect increased Cardiovascular Disease (CVD) risk. This trait explained the largest portion of the variance 21% for diabetics and 31% for controls. Therefore factor one is the strongest indicator for development of CVD among diabetics and controls. Factor 2 for diabetic subjects is loaded for age and age of onset of T2D. This factor explained nearly 15% of total variance. However, factor 2 for controls is loaded for WHR and the factor explained nearly 17% of the total variance.

Therefore factor two is identified as age among diabetics and WHR for controls which is related with obesity. Factor three for diabetic subjects is predominantly loaded with glucose concentration (FBS, RBS), however, all parameters in control group have negligible loading for factor 3. Factor 4 for diabetic subjects is loaded with obesity (BMI and WHR). While, in controls factor 4 is loaded with age.

Discussion

The result of the present analysis revealed that BMI, WHR, SBP, DBP, FBS, RBS and PP are closely and significantly related risk factors among Type 2 diabetic females. These factors may also acts as predictors for further risk estimation of CVDs. Through PCFA, present study provided evidence about the risk traits that require more attention by physicians for detection of high risk T2D development.

Earlier studies have also suggested the association of obesity, elevated glucose levels and hypertension with T2D [18-23]. In North Indian Punjabi females, very little information about the association of these risk factors using PCFA is available. PCFA has identified five factors for diabetic females with 65% explained variance and four factors with 72% explained variance among controls.

It is interesting to note that factor one clustered physiometric variables such as SBP, DBP and PP in both groups. However, SBP for both the groups is heavily loaded. The second factor could be identified as age and age of onset for diabetic females and WHR for control subjects. Therefore, among diabetic females, age and blood pressures are more closely associated as compared to control group. Factor three was loaded with fasting and random glucose levels among diabetic groups whereas only BMI had higher loading in control females. Factor four reflected BMI and WHR among type 2 diabetic subjects whereas for control samples, factor four represented age. However factor five was found to be of no consequence in control group and in diabetic females also negligible loading of factor 5 was observed.

The present factor analysis confirmed that cluster of three variables (SBP, DBP and PP) which were identified as factor one explained 21% and 31% of the total variance among diabetic and non diabetic females respectively. Therefore the cluster of blood pressure could be identified as cardio vascular risk variable and equally predisposing both diabetic and non diabetic subjects towards CVD development. Furthermore in the present study, the second factor that is age explained 14% of the total variance and factor three (glucose levels) explained 12% of the total variance among diabetic females. Therefore, from the above analysis it may be concluded that blood pressures, age and glucose

	Mean ± SD				
	----------	Mean difference			
Characteristics	Controls (250)	Cases (242)	(control-cases)	t Test	P value
Age (years)	47.23 (9.071)	54.12 (10.35)	-6.89	7.85	<0.001
BMI (Kg/m^2)	25.70 (4.97)	26.63 (5.47)	-0.93	1.97	0.048
WHR	0.94 (0.09)	0.97 (0.09)	-0.03	3.69	<0.001
SBP (mmHg)	135.61 (22.77)	142.34 (21.99)	-6.73	3.33	<0.001
DBP (mmHg)	87.36 (12.66)	89.27 (11.21)	-1.91	1.76	0.077
MBP (mmHg)	45.62 (35.47)	66.26 (21.93)	-20.64	7.73	<0.001
Pulse Pressure	30.88 (25.81)	49.12 (21.61)	-18.24	8.48	<0.001
Fasting glucose levels	87.2 (10.78)	185.4 (84.1)	-98.2	18.3	<0.001
Random glucose levels	104.43 (15.08)	225.91 (71.31)	-121.48	26.33	<0.001
Diet (veg/non-veg) in %	64.14/35.59	57.86/42.14	-	-	-
Age of onset of T2D	-	47.17 (9.64)	-	-	-
Duration of T2D (in years)	-	6.1 (0.7)	-	-	-
Cases under insulin treatment	-	6.99%	-	-	-
Duration of Insulin therapy (years)	-	1.8 (0.6)	-	-	-
Cases with positive family history of T2D	-	34.65%	-	-	-

*BMI=Body Mass Index, WHR= Waist-Hip ratio, SBP= Systolic blood pressure, DBP= Diastolic blood pressure, MBP= Mean blood pressure.

Table 1: Comparison of selected clinical characteristics between non-diabetic and diabetic female subjects

	Age	**BMI**	**WHR**	**FBS**	**RBS**	**SBP**	**DBP**	**PP**	**Age of onset**
Age		-0.016	0.073	-0.008	0.087	0.202**	0.087	0.182**	0.860**
BMI	-0.026		0.027	-0.133	-0.099	0.161*	0.264**	0.023	0.089
WHR	-0.013	0.038		-0.036	-0.045	0.147*	0.124	0.139*	0.14
FBS	0.067	0.166	0.046		0.321**	0.084	0.106	0.047	-0.164
RBS	0.182	0.268	0	-0.018		-0.091	0.003	-0.21	-0.021
SBP	0.258**	0.356**	-0.019	0.087	0.508*		0.686**	-0.887**	0.250**
DBP	0.180*	0.320**	-0.012	-0.001	-0.122	0.829**		0.0271**	0.152*
PP	0.290**	0.271**	-0.122	0.137	0.711**	0.866**	0.438**		0.223**
Age of onset	-	-	-	-	-	-	-	-	

*: Correlation is significant at the 0.05 level **: Correlation is significant at the 0.01 level; ¶FBS- Fasting Blood Glucose, RBS-Random Blood Glucose, SBP-Systolic Blood Pressure, DBP- Diastolic Blood Pressure, MBP- Mean Blood Pressure, PP- Pulse Pressure

Table 2: Correlation matrix of the variables included in factor analysis. The upper triangle shows the correlation values for diabetics and lower triangle shows correlation values for controls

Factor 1		Factor 2		Factor 3		Factor 4		Factor 5		
Variables	Diabetics	Controls	Diabetics	Controls	Diabetics	Controls	Diabetics	Controls	Diabetics	Controls
AGE	0.068	0.214	0.912	0.158	0.048	-0.242	0.137	0.819	0.003	-
BMI	0.252	0.384	0.071	0.094	-0.25	-0.433	0.621	-0.608	-0.051	-
WHR	-0.026	0.046	0.439	0.775	0.092	0.106	0.503	0.093	0.003	-
FBS	0.167	-	-0.118	-	0.66	-	-0.158	-	0.289	-
RBS	-0.165	-	0.061	-	0.844	-	0.051	-	-0.028	-
SBP	0.984	0.991	0.067	0.001	-0.032	-0.061	0.021	0.031	0.019	-
DBP	0.756	0.864	0.146	0.033	0.104	0.014	0.164	0.103	0.09	-
PP	0.855	0.86	error	-0.028	-0.107	-0.113	-0.072	0.143	0.08	-
AOO	0.142	-	0.919	-	0.12	-	0.03	-	0.011	-
Eigen value	2.682	2.782	1.891	1.515	1.625	1.159	1.24	1.053	1.077	-
Total variance	20.62	30.915	14.54	16.829	12.498	12.881	9.535	11.701	8.282	-
Cumulative variance	20.62	30.915	35.17	47.744	47.668	60.625	57.203	72.325	65.486i	-

Table 3: Coefficients and variances of the factors satisfying the eigenvalue ≥1 criterion for type 2 diabetes risk factors

concentrations could be considered as the most significant predictors for T2D in Punjabi females. Besides, analysis reduced risk factors from 9 to 5 showing association with T2D amongst Punjabi females. As these factors are uncorrelated, each can be used to interpret and represent as distinct trait for underlined T2D risk in Punjabi females. It is assumed that these factors would be influenced by strong genetic components. However present cross sectional study doesn't elaborate the genetic component.

Conclusion

Based on the presetn study, we construe that out of the 9 identified risk variables, the unfavorable factors SBP, DBP and PP confir maximum risk to Punjabi females, followed by age/age of onset, glucose levels, BMI and WHR. However, further family based and case control association studies on larger sample size are envisaged to enhance our understaing on T2D at the population level.

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