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Full Length Research paper

Effect of sex on prevalence of type 2 diabetes mellitus (T2DM) with respect to blood pressure, BMI and WHR among Punjabi population

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The objective of the study is to assess the impact of type 2 diabetes mellitus on sex differences among Punjabi population. In the present cross-sectional study, a total of 400 individuals (range in age 30 to 70), constituting 203 male and 197 female individuals were recruited. All enrolling individuals were at high risk of type 2 diabetes. The present samples were selected for particular trait, therefore, this sample may be considered as non random sample with no overlapping. Almost all studied risk factors like age, age of onset, BMI, WHR, pulse rate, socioeconomic status, occupation and blood pressure phenotypes have higher correlation ($p<0.001$) with the occurrence of type 2 diabetes among both sexes. The males with type 2 diabetes are accompanied by more unfavourable variables such as BMI, waist circumference, WHR, SBP and DBP as compared to female type 2 diabetic individuals. Socioeconomic status, reproductive status (pre-menopause/ post-menopause) and physical activity have significant ($p<0.001$) impact on the occurrence of type 2 diabetes among female individuals. The multivariate regression analysis confirmed that age, BMI, WHR and socioeconomic status are significant predictor for the occurrence of type 2 diabetes among both sexes. The present multivariate analysis with respect to many environmental variables strengthen the hypothesis that alcohol consumption, smoking, physical activity, food habits, physical fitness and hours spent in watching TV and sleeping are significantly associated with the occurrence of Type 2 diabetes. It is interestingly observed that the pre-menopausal or round about pre-menopausal age of females is more prone to develop Type 2 diabetes as compared to postmenopausal age of females.

Key words: Type 2 diabetes, blood pressure, BMI, WHR, Punjabi population.

INTRODUCTION

Type 2 diabetes mellitus is an important public health problem in developed and developing countries like India. It is well documented (Ramachandran et al., 2000; Kanaya et al., 2002; Park et al., 2004; Wild et al., 2004; Freemantle et al., 2008) that type 2 diabetes is significantly correlated with the presence of many risk factors such as blood pressure, BMI, WHR, coronary heart disease, gender difference, advancing of age, diet and obesity. The rapid expansions of economy and urbanization in recent years in Indian subcontinent have changed lifestyle in many folds. These changes involving major deviation of diet pattern decreased physical activity and increased high level of mental stress etc (Mohan et al., 1986; McKeigue et al., 1991; Davey et al., 2000; Abate et al., 2001; Ramachandran et al., 2003; Mohan et al., 2007; Mehta et al., 2009). Therefore the occurrence of this disease is increasing in India due to the quick changing towards western lifestyle. Hence, in a country like India with the burden of type 2 diabetes and its complications, early screening and diagnosis have immense importance to achieve the goal of reduction of frequency to the disease. It is highly recommended for lifestyle changes, diet control and proper medication to prevent or reduce the existence of type 2 diabetes.

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The genetic predisposition is also an important factor for the development of type 2 diabetes. Significant familial aggregation of type 2 diabetes have been reported in many studies (Ramachandran et al., 2000; Das, 2006; Ramandeep, 2009) which may also support a genetic predisposition to the development of type 2 diabetes. Therefore, this is a disease produced by the combination of genetic and environmental factors. However, very scanty data regarding the population based and systematic study for the occurrence of this disease are available in India. It is interesting to note that estimation of the variation in relative risk of the occurrence of type 2 diabetes is varied in male and female. Few studies have reported that men are more prone to develop type 2 diabetes after certain stage of life (Ericksson et al., 1991; Pan et al., 1997; Kanaya et al., 2002; Williams et al., 2003; Amini and Janghorbani, 2007) as compared to women. It has been suggested that sexual dimorphism may play some role after certain stage of life to develop type 2 diabetes (Perreault et al., 2008). Therefore, the objectives of present study are to examine the sex differences in risk factors for type 2 diabetes and compare the occurrence of type 2 diabetes in men versus women.

MATERIALS AND METHODS

Samples

A total of 400 individuals, constituting 203 male and 197 female individuals were recruited for the present study among Punjabi population and all enrolling individuals were at high risk of type 2 diabetes. The age range of recruited males and females were in between 30 to 70 years. The present samples were selected for particular trait and therefore, this sample may be considered as non random sample with no overlapping. For data collection, personal interviews were held with each subject. The general information for various anthropometric, physiometric, environmental and calculated variables was obtained. The information was also collected for any other existing disease or disorder beyond type 2 diabetes. All this obtained information was recorded on a pre-designed Performa. All procedure related assessments of the subjects were approved by the ethical committee of Guru Nanak Dev University, Amritsar, Punjab in 2008 and all subjects made a written consent. The number of complete illiterate subjects is nearly negligible in the present samples.

Measurements

The anthropometric measurements taken were height (cm), weight (kg), waist circumference (cm), hip circumference (cm). The physiometric variables included systolic blood pressure (SBP), diastolic blood pressure (DBP) and pulse rate. All the anthropometric measurements were taken on each individual using standard anthropometric techniques (Singh and Bhasin, 1968; Weiner and Lourie, 1981).The age of the individuals was determined directly from their reported date of birth. The age of onset of the type 2 diabetes of the individuals was determined through retrospective methods.

Anthropometric variables

Height (cm) was measured the vertical distance from the point vertex to the base of the heels using anthropometric rod. The reading was recorded to the nearest 0.1 cm. The weight of the subject was measured in kilograms by making him stand on a weighing machine with minimal clothing. Weight was recorded with an allowance deducted for clothing and the values were rounded off to the nearest 0.5 kg. Waist circumference was measured using a steel tape. The subject was asked to stand erect with feet 25 - 30 cm apart and weight evenly distributed with abdomen relaxed. The measurement is taken mid-way between the inferior margin of the last rib and the crest of the ilium in a horizontal plane. The tape was fitted snugly without compressing the soft tissue. Hip circumference of the subject was taken with steel tape fitted around the pelvis at the point of maximal protrusion of buttocks while the subject was standing with his/her feet close to each other. Body mass index (BMI) was calculated by dividing weight of the subject in kilograms by square of his/her height in meters. Waist to hip ratio is calculated as waist circumference (cm) divided by hip circumference (cm).

Physiometric variables

The measurements were taken with the help of mercury sphygmomanometer in a sitting position with the right forearm placed horizontal on the table. The recordings were taken as recommended by the American Heart Association (1981). An appropriate sized cuff was fitted on the arm of the subject and was inflated to about 20 mmHg above the point at which the radial pulse disappeared. The pressure within the cuff was then, released at a rate of approximately 2 mmHg/second, while osculating with a stethoscope placed over the brachial artery. The onset of sound (Korotkoff- phase I) was taken as indicative of systolic blood pressure and the disappearance of sound (Korotkoff- phase V) was taken as indicative of diastolic blood pressure (Londe and Goldring, 1976). Two consecutive readings were recorded for each of SBP and DBP and the averages were used. All efforts were made to minimize the factors which might affect blood pressure like anxiety, fear, stress, laughing and recent activity (Badaruddoza and Afzal, 1999). Mean Arterial blood pressure (MBP) was calculated for each of the two readings taken for SBP and DBP by using the formula: MBP= DBP + (SBP- DBP)/3 (Perusse et al., 1989). Pulse rate is the strongest in the arteries closest to the heart. It becomes weaker in the arterioles and disappears altogether in the capillaries. The radial artery at the wrist is most commonly used to feel the pulse. It was counted over one minute. Pulse pressure is calculated through SBP minus DBP.

Environmental variables

For extensive study of the occurrence of type 2 diabetes, the information of environmental variables related lifestyle such as alcohol consumption, smoking, physical activities, sports, food habits, physical fitness, watching TV and sleeping have been collected. All statistical analysis have been done through SPSS-17.0 software and significance level was considered at $p<0.05$ for all analysis.

Table 1. Descriptive statistics and test of comparison with level of significance value for different anthropometric and physiometric variables among type 2 diabetic Punjabi male (n = 203) and female (n = 197) individuals.

Variables	Male		Female			
	Mean	SD	Mean	SD	t	P
Age (years)	57.19	5.63	54.49	5.60	6.87	<0.001
Age of onset (years)	48.07	6.80	46.05	5.61	4.61	<0.001
Height (cm)	167.18	6.78	155.72	6.53	24.59	<0.001
Weight (kg)	74.67	7.69	63.93	7.04	20.77	<0.001
BMI (kg/m^2)	26.83	4.15	26.32	4.29	1.72	NS
Waist circumference (cm)	96.79	6.14	94.25	8.39	4.94	<0.001
Hip circumference (cm)	98.05	7.58	99.61	7.73	2.90	<0.01
WHR	0.99	0.06	0.95	0.07	8.16	<0.001
SBP (mm Hg)	137.56	10.51	135.84	10.08	0.23	NS
DBP (mm Hg)	91.51	9.92	88.60	9.41	0.30	NS
MBP (mm Hg)	107.25	10.36	105.13	8.25	2.93	<0.01
Pulse rate (per minute)	85.13	5.22	85.72	5.72	1.54	NS
Pulse pressure (mm Hg)	45.74	4.08	47.37	4.58	5.37	<0.001

NS = Not significant at 5% level.

RESULTS

Descriptive statistics and their comparison of different means with t and p values with respect to all measured variables are presented in Tables 1 among type 2 diabetic male and female individuals. The mean age and standard deviation for males and females are 57.19 ± 5.63 and 54.49 ± 5.60, respectively. The average ages for the onset of type 2 diabetes are 48 years in males and 46 years in females, respectively. The maximum mean values of the measurements such as height, weight, body mass index, waist circumference, waist-hip-ratio, SBP, DBP and MBP are found among male type 2 diabetic individuals. However the mean values of hip circumference, pulse rate and pulse pressure are found maximum in female type 2 diabetic individuals. It has been observed that difference of all variables except body mass index, systolic blood pressure, diastolic blood pressure and pulse rate are found statistically significant at least at 1% level ($p<0.01$). All measured mean values except hip circumference, pulse rate and pulse pressure are statistically higher among male type 2 diabetic individuals than female type 2 diabetic individuals.

Estimates of correlations for systolic and diastolic blood pressures with other variables along with their significant levels among type 2 diabetic male and female individuals are presented in Table 2. It has been observed that systolic and diastolic blood pressures have significant associations (at least $p<0.01$) with age, age of onset the disease, occupation, alcohol consumption, smoking, hours spent in watching TV and sleeping among males; with WHR among only females; with BMI, waist circumference, pulse rate and pulse pressure among both males and females. Estimates of correlations for body mass index and waist-hip-ratio with other variables along with their significant levels among type 2 diabetic male and female individuals are presented in Table 3. Age, Height, weight, waist circumference, hip circumference and hours spent in watching TV have significant (at least $p<0.01$) associations with body mass index among both sexes. It has also been observed that many characters such as age, weight, waist and hip circumferences, physical activities and sleeping have significant associations (at least $p<0.01$) with waist-hip-ratio among both sexes. However, quantity of alcohol consumption per day has significant (at least $p<0.01$) association with waist-hip-ratio among male individuals.

The results of multivariate regression analysis to test the significant predictors of blood pressure (SBP and DBP), body mass index and waist-hip-ratio (all are act as dependent variables) among type 2 diabetic male and female individuals are presented in Tables 4 and 5, respectively. The dependent variable systolic blood pressure can be predicted from the linear combinations of many significant (at least $P< 0.05$) independent variables such as BMI, waist and hip circumferences, WHR, pulse pressure, economic status, physical activities and sleeping among both male and female type 2 diabetic individuals. However, coefficients of age, alcohol consumption and smoking among males and pulse rate among females are also statistically significant (at least $P< 0.05$), respectively and act as good predictors. The

Table 2. Correlation coefficients for SBP and DBP with other variables among type 2 diabetic male and female individuals.

Variables	SBP				DBP			
	Male		Female		Male		Female	
	r	P	r	P	r	P	r	P
Age (years)	0.15	<0.05	0.07	NS	0.16	<0.05	0.03	NS
Age of onset of disease (years)	0.20	<0.01	0.07	NS	0.21	<0.01	0.10	NS
Height (cm)	0.07	NS	0.07	NS	0.06	NS	0.01	NS
Weight (kg)	0.01	NS	0.09	NS	0.09	NS	0.05	NS
BMI	0.18	<0.05	0.13	<0.05	0.19	<0.05	0.17	<0.05
Waist circumference (cm)	0.22	<0.01	0.20	<0.01	0.25	<0.001	0.21	<0.01
Hip circumference (cm)	0.05	NS	0.07	NS	0.06	NS	0.06	NS
WHR	0.01	NS	0.23	<0.001	0.20	<0.01	0.24	<0.001
Pulse rate (per minute)	0.49	<0.001	0.54	<0.001	0.41	<0.001	0.90	<0.001
Pulse pressure (mmHg)	0.73	<0.001	0.74	<0.001	0.81	<0.001	0.75	<0.001
Reproductive status	-	-	-0.05	NS	-	-	-0.01	NS
Occupation	0.18	<0.01	0.05	NS	0.24	<0.001	0.04	NS
Economic status	0.06	NS	0.03	NS	0.08	NS	0.05	NS
Alcohol consumption	0.21	<0.01	-	-	0.21	<0.01	-	-
Smoking	0.24	<0.001	-	-	0.25	<0.001	-	-
Physical activates	-0.09	NS	-0.06	NS	-0.07	NS	0.04	NS
Food habits	0.05	NS	0.08	NS	0.02	NS	0.05	NS
Physical fitness	-0.07	NS	0.01	NS	0.09	NS	0.04	NS
TV	0.24	<0.001	-0.06	NS	0.014	<0.05	0.06	NS
Sleeping	0.23	<0.001	0.07	NS	0.25	<0.001	0.27	<0.001

NS = Not significant at 5% level.

Table 3. Correlation coefficients for BMI and WHR with other variables among type 2 diabetic male and female individuals.

Variables	BMI				WHR			
	Male		Female		Male		Female	
	r	P	r	P	r	P	r	P
Age (years)	0.22	<0.01	0.24	<0.01	0,21	<0.01	0,20	<0.01
Age of onset (years)	0.06	NS	0.02	NS	0.01	NS	0.08	NS
Height (cm)	0.14	<0.05	0.13	<0.05	0.01	NS	0.07	NS
Weight (kg)	0.70	<0.001	0.85	<0.001	0.15	<0.01	0.26	<0.001
Waist circumference (cm)	0.68	<0.001	0.50	<0.001	0.14	<0.05	0.33	<0.001
Hip circumference (cm)	0.61	<0.001	0.66	<0.001	0.33	<0.01	0.48	<0.001
Pulse rate (per minute)	0.09	NS	0.09	NS	-0.00	NS	-0.10	NS
Pulse pressure (mmHg)	0.01	NS	0.13	<0.05	0.02	NS	0.05	NS
Reproductive status	-	-	0.01	NS	-	-	0.07	NS
Occupation	0.02	NS	0.01	NS	0.06	NS	0.05	NS
Economic status	0.10	NS	0.06	NS	0.07	NS	0.16	<0.01
Alcohol consumption	0.18	<0.01	-	-	0.14	<0.01	-	-
Smoking	0.07	NS	-	-	0.02	NS	-	-
Physical activities	0.03	NS	0.04	NS	0.21	<0.001	0.14	<0.05
Food habits	0.04	NS	0.02	NS	0.11	NS	0.05	NS
Physical fitness	0.09	NS	0.17	NS	0.08	NS	0.02	NS
TV	0.13	<0.05	0.16	<0.01	0.08	NS	0.07	NS
Sleeping	0.15	<0.05	0.01	NS	0.24	<0.001	0.03	NS

NS = Not significant at 5% level.

dependent variable diastolic blood pressure can also be predicted from the linear combinations of independent variables such as BMI, waist and hip circumferences, WHR, pulse pressure and economic status among type 2 diabetic male and female individuals. However the coefficients of age, alcohol consumption, smoking and physical activities for males and pulse rate for females were significant (at least $p<0.05$) (Table 4). The dependent variable BMI can be predicted from the linear combinations of the independent variables such as age, height, weight, waist and hip circumferences, WHR, physical activities, food habits, physical fitness and sleeping among both male and female type 2 diabetic individuals. It has also been found from the above analysis that the dependent variable waist-hip-ratio can be well predicted from the linear combination of the independent variables such as weight, waist and hip circumferences among both male and female type 2 diabetic individuals (Table 5).

DISCUSSION

The major purpose of the present study was two fold (i) to examine the sex differences in risk factors for type 2 diabetes (ii) to compare the occurrence of type 2 diabetes in men versus women. The total objectives were examined in the Punjabi population in Punjab. The observations were done from many health centres in different villages and diabetic clinics from urban areas. As regards of the present objective many interesting results are found and will be discussed one by one. Significant ($p<0.05$) sex differences with respect to onset of type 2 diabetes was observed. Females have higher risk to develop type 2 diabetes in lower age (46 years) as compared to male counterpart (48 years). The present result indicated that males have higher risk factor to develop accessory abnormalities like coronary heart disease (increased SBP and DBP), obesity (increased BMI and WHR) as compared to the females. From the present descriptive analysis of the data, it may be suggested that male type 2 diabetic individuals are accompanied more by unfavourable variables such as BMI, WC, WHR, SBP, DBP and MBP as compared to female type 2 diabetic individuals. Many previous studies (Hussain et al., 2006; Amini and Janghorbani, 2007) have also supported the hypothesis that males are more prone to bear many unfavourable risk factors of type 2 diabetes than females. However, the meta analysis (Kanaya et al., 2002) of many previous studies have found that females with type 2 diabetes were significantly at higher risk to develop the cardiovascular diseases than compared with males.

The significance (<0.05) correlations for many risk factors such as age, age of onset, BMI, waist circumference, pulse rate, pulse pressure, occupation, alcohol consumption, smoking and duration of sleep (hours per day) with systolic and diastolic blood pressures (SBP and DBP) have been found among male type 2 diabetic individuals as compare to female. It has also been found that the factors such as age, weight, waist and hip circumferences are equally responsible to increase BMI and WHR among both male and female type 2 diabetic individuals. For further analysis, blood pressure phenoltypes, body mass index and waist-hip-ratio were regressed on all other sets of variables by using multiple regression models among male and female type 2 diabetic individuals. The overall present analysis suggested that regardless of the back ground of individuals, blood pressure phenotypes (SBP and DBP), body mass index and waist-hip-ratio appear to be significantly associated with the occurrence of type 2 diabetes among both male and female individuals. Many previous studies have supported the present results (McKeigue et al., 1996; Sayeed et al., 1998; Hussain et al., 2006; Amini and Janghorbani, 2007 and Mohan et al., 2007; Nemesure et al., 2008). It can be thus concluded from multivariate regression analysis that age, body mass index, waist and hip circumferences, waist-hip-ratio and socioeconomic status are strong predictors and risk factors for the occurrence of type 2 diabetes among both the sexes, whereas, alcohol consumption and smoking are important risk factors for the occurrence of type 2 diabetes in males.

The present study has found a higher prevalence of type 2 diabetes with increased risk of blood pressure phenotypes, body mass index and waist-hip-ratio in males than in females and this observation is consistent with many previous studies (DECODE study group, 2003; Glumer et al., 2003; Hanefeld et al., 2003; and Williams et al., 2003). Some studies have suggested that female sex hormones may contribute some protection role for the occurrence of type 2 diabetes among females (Margolis et al., 2004; Van Genugten et al., 2006). Therefore, it may be concluded from the present study that some modification (such as control of SBP, DBP, BMI and WHR) of lifestyle may help in preventing the onset of type 2 diabetes and cardiovascular diseases. This suggestion has also been supported by the Indian Diabetes Prevention Programme (IDPP) which has clearly documented the importance of physical activity in the prevention of diabetes (Hu et al., 2005; Ramachandran et al., 2006). Therefore, early tracking of high risk individuals could help appropriate intervention in the form of dietary changes and increasing physical activity to prevent or at least delay the onset of disease. Hence, it is necessary to create massive public awareness about type 2 diabetes and other related disorders especially in a developing country like India. One other important point worth to mention from the present

Table 4. Calculation of significant predictors through multiple regression analyses for developing type 2 diabetes among males and females, when SBP and DBP act as a dependent variable, respectively.

Variables	SBP						DBP					
	Male			Female			Male			Female		
	β	SD	P	β	SD	p	β	SD	p	β	SD	p
Age (years)	0.05	0.014	<0.01	0.104	0.993	NS	0.06	0.014	<0.01	0.018	0.015	NS
Age of onset of disease (years)	0.020	0.013	NS	0.193	0.161	NS	0.024	0.013	NS	0.016	0.012	NS
Height (cm)	0.027	0.020	NS	0.717	0.606	NS	0.030	0.021	NS	0.081	0.070	NS
Weight (kg)	0.005	0.003	NS	0.955	0.727	NS	0.004	0.003	NS	0.118	0.115	NS
BMI (kg/m^2)	0.080	0.048	<0.01	2.337	0.781	<0.001	0.090	0.039	<0.01	0.407	0.130	<0.01
W.C (cm)	0.055	0.020	<0.01	0.248	0.085	<0.01	0.047	0.008	<0.001	0.070	0.020	<0.01
H.C (cm)	0.034	0.002	<0.01	0.224	0.030	<0.001	0.046	0.008	<0.01	0.058	0.028	<0.05
WHR	4.068	1.01	<0.01	4.123	1.03	<0.01	3.525	0.770	<0.001	0.042	0.003	<0.001
P. R (per minute)	0.018	0.010	NS	1.437	0.161	<0.001	0.025	0.027	NS	0.287	0.015	<0.001
P. P (mmHg)	0.968	0.015	<0.001	0.897	0.084	<0.001	0.952	0.034	<0.001	0.231	0.080	<0.01
Reproductive Status	--	--	--	0.244	0.183	NS	--	--	--	0.020	0.011	NS
Occupation	0.182	0.155	NS	2.032	1.524	NS	0.167	0.158	NS	0.223	0.21	NS
Economic Status	0.856	0.403	<0.01	2.669	0.507	<0.01	0.871	0.411	<0.01	0.243	0.080	<0.01
Alcohol consumption	0.296	0.077	<0.01	--	--	--	0.257	0.019	<0.001	--	--	--
Smoking	0.852	0.362	<0.01	--	--	--	0.485	0.12	<0.01	--	--	--
Physical activities	0.358	0.112	<0.01	0.917	0.336	<0.01	0.162	0.04	<0.01	0.278	0.161	NS
Food Habits	0.077	0.055	NS	2.201	1.987	NS	0.054	0.03	NS	0.344	0.217	NS
Physical fitness	0.120	0.10	NS	4.679	3.681	NS	0.276	0.229	NS	0.146	0.110	NS
TV	0.035	0.021	NS	2.033	1.883	NS	0.089	0.065	NS	0.252	0.110	NS
Sleeping	0.209	0.021	<0.01	1.185	0.34	<0.01	0.059	0.030	NS	0.024	0.010	NS

NS = Not significant at 5% level; WC = waist circumference; HC = hip circumference; PR = pulse rate; PP = pulse pressure.

analysis is that age and age of onset of this disease significantly differ between the sexes. Further, it is interestingly observed that premenopausal or round about premenopausal age of females is more prone to develop type 2 diabetes as compared to the post menopausal females. However the exact mechanism for this finding is not well understood but a selection process of hormonal imbalance may be one of the reasons.

Limitations of the study

The present study has several strengths as well as some limitations. The strengths include the moderately large sample size consisting of both males and females with sound representativeness of type 2 diabetes. Many important information on potential determinants of type 2 diabetes have been collected through well designed questionnaire, however not all information is analysed in the present project work. As a cross-sectional study, the present analysis has some limitations. Several studies have shown that

Table 5. Calculation of significant predictors through multiple regression analyses for developing type 2 diabetes among males and females, when BMI and WHR act as a dependent variable, respectively.

Variables	BMI						WHR					
	Male			Female			Male			Female		
	β	SD	p	β	SD	p	β	SD	p	β	SD	p
Age (years)	0.053	0.028	<0.05	0.055	0.008	<0.001	0.070	0.01	<0.01	0.201	0.17	NS
Age of onset of disease (yrs)	0.016	0.011	NS	0.008	0.006	NS	0.006	0.005	NS	0.004	0.003	NS
Height (cm)	0.239	0.037	<0.001	0.325	0.008	<0.001	0.006	0.004	NS	0.008	0.006	NS
Weight (kg)	0.203	0.021	<0.001	0.399	0.006	<0.001	0.009	0.002	<0.001	0.005	0.001	<0.01
BMI (kg/m^2)	--	--	--	--	--	--	0.006	0.004	NS	0.002	0.001	NS
W.C (cm)	0.008	0.002	<0.01	0.061	0.010	<0.01	0.008	0.001	<0.001	0.009	0.001	<0.001
H. C (cm)	0.088	0.020	<0.001	0.083	0.025	<0.01	0.004	0.001	<0.01	0.009	0.001	<0.001
WHR	4.632	2.294	<0.05	1.225	0.352	<0.01	--	--	--	--	--	--
SBP (mmHg)	0.003	0.025	NS	0.024	0.011	NS	0.003	0.002	NS	0.004	0.003	NS
DBP (mmHg)	0.020	0.017	NS	0.041	0.028	NS	0.004	0.003	NS	0.003	0.002	NS
MBP (mmHg)	0.028	0.01	NS	0.031	0.028	NS	0.006	0.004	NS	0.003	0.001	NS
Pulse rate (per minute)	0.038	0.024	NS	0.004	0.003	NS	0.008	0.006	NS	0.003	0.002	NS
Pulse pressure (mmHg)	0.008	0.042	NS	0.021	0.012	NS	0.006	0.005	NS	0.002	0.001	NS
Reproductive status	--	--	--	0.075	0.051	NS	--	--	--	0.008	0.005	NS
Occupation	0.070	0.053	NS	0.052	0.041	NS	0.003	0.001	NS	0.004	0.003	NS
Economic statues	0.542	0.112	<0.01	0.210	0.130	NS	0.003	0.002	NS	0.006	0.004	NS
Smoking	0.402	0.300	NS	--	--	--	0.053	0.038	NS	--	--	--
Physical activities	0.208	0.044	<0.001	0.094	0.029	<0.01	0.017	0.013	NS	0.004	0.003	NS
Food habits	1.011	0.492	<0.05	0.536	0.103	<0.01	0.033	0.019	NS	0.004	0.003	NS
Physical fitness	0.594	0.112	<0.01	0.623	0.191	<0.01	0.004	0.002	NS	0.005	0.005	NS
TV	0.670	0.246	<0.01	0.108	0.097	NS	0.025	0.017	NS	0.003	0.001	NS
Sleeping	0.743	0.288	<0.01	0.118	0.027	<0.01	0.016	0.014	NS	0.009	0.003	<0.001

NS = Not significant at 5% level; WC = waist circumference; HC = hip circumference; PR = pulse rate; PP = pulse pressure.

measures of obesity have a strong heritability for the occurrence of type 2 diabetes (Selby et al., 1990). This suggests that the genetic factors besides lifestyle are also responsible for the development of this disease. Therefore the present study was unable to collect family data to analyse the pattern of familial aggregation and heritability.

REFERENCES

Abate N, Chandalia M (2001). Ethnicity and type 2 diabetes: focus on Asian Indians. J. Diabet. Complications. 51: 445-446.

American Heart Association (1981). Report of Sub committee of postgraduate education committee recommendations for human blood pressure determination of sphygmomanometer. Circulation. 64: 510A-599B.

Amini M, Janghorbani M (2007). Diabetes and impaired Glucose Regulation in First- Degree Relatives of Patient

with type 2 diabetes in Isfahan, Iran: Prevalence and Risk factors. Rev. Diabet. Stud., 4: 169-176.
Badaruddoza, Afzal M (1999). Age specific difference in blood pressure among inbred and non inbred north Indian children. J. Biosci., 24: 177-184.
Das S (2006). Genetic Epidemiology of Adult onset type 2 diabetes in Asian Indian population: Past, Present and Future. Int. J. Hum. Genet. 6: 1-13.
Davey G, Ramachandran A, Snehalatha C, Hitman GA, McKeigue PM (2000). Familial aggregation of central obesity in southern Indians. Int. J. Obesity, 24: 1523-1528.
Decode Study Group (2003). Age and sex specific prevalence of diabetes and impaired glucose regulation in 13 European cohorts. Diabet. Care, 26: 61-69.
Ericksson KF, Lindgrade F (1991). Prevention of type 2 (non insulin-dependent) diabetes mellitus by diet and physical exercise. The 6-year Malmo feasibility study. Diabetologia 34: 891-898.
Freemantle N, Holmes J, Hockey A, Kumar S (2008). How strong is association between abdominal obesity and the incidence of type 2 diabetes. Int. J. Clin. Pract., 9: 1391-1396.
Glumer C, Jorgensen T, Borch-Johnsen K (2003). Prevalence of diabetes and impaired glucose regulation in a Danish population: the Inter 99 study. Diabet. Care., 26: 2335-2340.
Hanefeld M, Koehler C, Fuecker K, Henkel E, Schaper F, Temelkova KT (2003). Insulin secretion and insulin sensitivity pattern is different in isolated impaired glucose tolerance and impaired fasting glucose: the risk factor in impaired glucose tolerance for atherosclerosis and Diabetes study. Diabet. Care., 26: 868-874.
Hu G, Jousilahti P, Barengo N, Qiao Q, Lakka TA, Tuomilehto J (2005). Physical activity, cardiovascular risk factors and mortality among Finish adults with diabetes. Diabet. Care., 28: 799-805.
Hussain A, Vaaler S, Sayeed MA, Mahtab H, Keramat ASM, Azad KAK (2006). Type 2 diabetes and impaired fasting blood glucose in rural Bangladesh: a population based study. Eur. J. Public Health., 17: 291-296.
Kanaya AM, Grady D, Barrett-Comor E (2002). Explaining the Sex Difference in coronary heart disease mortality among patients with type 2 diabetes mellitus. Arch. Intern. Med., 162: 1737-1745.
Londe S, Goldring D (1976). High Blood pressure in children: Problems and Guidelines for evaluation and treatment. Am. J. Cardial., 37: 650-657.
McKeigue PM, Shah B, Marmot MG (1991). Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. Lancet. 337: 382-386.
Mehta SR, Kashyap AS, Das S (2009). Diabetes Mellitus in India: The Modern Scourge. MJAFI. 65: 50-54.
Mohan V, Sandeep S, Deepa R, Shah B, Varghese C (2007). Epidemiology of type 2 diabetes: Indian Scenaio. Ind. J. Med. Res., 125: 217-230.
Mohan V, Sharp PS, Cloke HR, Burrin JM, Schumer B, Kohner EM (1986). Serum immunoreactive insulin responses to a glucose load in Asian Indian and European Type 2 (non insulin dependent) diabetic patients and control subjects. Diabetologia 29: 235-237.
Nemesure B, Wu SY, Hennis A, Leske MC, BES Study Group (2008). The relationship of BMI and WHR on the 9 years incidence of type 2 diabetes and hypertension in a predominantly African origin population. Ann. Epidemiol., 18: 657-663.
Pan XR, Li GW, Hu YM, Wang JX, Yang WY (1997). Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes study. Diabet. Care., 20: 537-544.
Park HS, Yim KS, Cho SI (2004). Gender differences in familial aggregation of obesity-related phenotypes and dietary intake pattern in Korean families. Ann. Epidemiol. 14: 486-491.
Perreault L, Yong, Jack SD, Horton E, Marreo D, Crandeal J, Connor EB (2008). Sex differences in Diabetes Risk and the Effect of Intensive lifestyle Modification in the diabetes Prevention program. Diabet. Care., 31: 1416-1421.
Perusse L, Rice T, Bouchard C, Vogler GP, Rao DC (1989). Cardiovascular risk factors in the French Canadian population: Resolution of genetic and familial environmental effects on blood pressure by using extensive information on environmental correlates. Am. J. Hum. Genet., 45: 240-251.
Ramachandran A, Snehalatha C, Latha E, Satyavani K, Viswanathan V (2003). Metabolic syndrome in Urban Asian Indian adults: A population on study using modified ATP III criteria. Diabet. Prac. Res. Clin., 60: 199-204.
Ramachandran A, Snehalatha C, Mary S, Mukesh B, Bhaskar AD, Vijay V (2006). Indian Diabetes Prevention programme (IDPP). The Indian diabetes Prevention programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1). Diabetologia. 49: 289-297.
Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V (2000). Cosegregation of obesity with familial aggregation of type 2 diabetes mellitus. Diabet. Obes. Metab., 2: 149-154.
Sayeed MA, Banu A, Malek MA, Khan AK (1998). Blood pressure and coronary heart disease in NIDDM subjects at diagnosis: prevalence and risks in Bangladeshi population. Diabet. Res. Clin. Pract. 39: 147-155.
Selby JV, Newman B, Quesenberry CP (Jr), Fabsitz RR, Carmelli D, Meaney FJ, Slemenda L (1990). Genetic and behaviour on body fat distribution. Int. J. Obes. 14: 593-602.
Singh IP, Bhasin MK (1968). Anthropometry. Kamla-Raj Enterprises. Delhi.
Van Genugten RE, Utzschneider KM, Tong J, Gerchman F, Zraika S, Udayasankar J, Boyko EJ, Fujimoto WY, Kahn SE (2006). American Diabetes Association GENNID study group. Effects of sex and hormone replacement therapy use on the prevalence of isolated impaired fasting glucose and isolated impaired glucose tolerance in subjects with a family history of type 2 diabetes. Diabetes. 55: 3529-3535.
Weiner JS, Lourie JA (1981). Practical Human Biology. Academic Press, London.
Wild S, Roglic G, Green A, Sicree R, King H (2004). Global prevalence of diabetes. Estimates for the year 2000 and projections for 2030. Diabet. Care. 27: 1047-53.
Williams JW, Zimmet PZ, Shaw JE, de Courten MP, Cameron AJ, Chitson P, Tuomileh J, Alberti KG (2003). Gender differences in the prevalence of impaired fasting glycemia and impaired glucose tolerance in Mauritius: does sex matter? Diabet. Med., 20: 915-920.