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Impact of Hypertension on Type 2 Diabetic patients of Rajahmundry, Andhra Prasad, India

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Abstract

The objective of the present study is to investigate the incidence of hypertension and impact of it on Type 2 diabetes mellitus (T2DM) in and around Rajahmundry including rural population of North East of Andhra Prasad, India during 2013-16
In the present study the sample was1010 individuals. But those who responded are 884. Among them 600 were diabetic and the rest 284 non-diabetic. Anthropometric measurements and blood pressure were noted. The plasma was analyzed for biochemical markers. To define diabetes and hypertension diagnostic criteria of IDF and JNC 7 were followed. X^2-test, Logistic regression analysis were used to evaluate the mean, proportion and the independent effect of hypertension for the development of T2DM. Hypertension was observed to be prevalent in 38.2% of the studied population with significant gender difference. Rate of occurrence of hypertension was significantly higher in type 2 diabetes (52.9%), obese subjects (47.2%), long-term smokers (52%) and alcohol addicts (54%) than control groups. The risk of development of diabetes was significantly higher in hypertensive than normal blood pressure individuals. The prevalence of T2DM and hypertension is rising at an alarming pace. The present study reveals that the impact of hypertension as a factor in predicting the risk of T2DM and may be influenced by the renal function and lipid profile.
Keywords: Hypertension (HPTN), Type 2 Diabetes (T2DM), Prevalence of Diabetes (PODIS), Lipid profile, Anthropometric measurements

Introduction

The prevalence of T2DM is increasing round the globe from 2.8% in 2000 to 4.4% in 2030 [1]. The incidence of T2DM in Asian Indians is ranging from 2.7% in rural India. India has the highest diabetics in the world [2,3]. The prevalence of hypertension (HPTN) in adults is expected to rise by 60% resulting in a total of 1.56 billion affected individuals by 2025. Approximately 70% of diabetics are hypertensive, as diabetics are prone to HPTN twice when compared to normoglycemic individuals [5]. The presence of HPTN is one of the factor for the onset of T2DM [6,7]. Hypertension leads to diabetes and in diabetic individuals HPTN leads to diabetic complications like nephropathy and retinopathy. The incidence HPTN and T2D simultaneously affects about 60% of patients leading to high risk of developing cardiovascular morbidity and mortality [8]. The United Kingdom Prospective Diabetes Study (UKPDS) revealed that

control of blood pressure l helps to prevent cardiovascular complications T2DM patients [10]. The decrease by 10 mm/Hg in mean systolic blood pressure reduces the risks of developing 12%, complications in diabetics, 15% of mortality rate, 11% myocardial infraction and 13% micro vascular complications among diabetics respectively [11]. The prevalence varies across different ethnic and religious groups in Asia. The occurrence of diabetes and HPTN shows an increasing tendency and is of great epidemic concern [12]. About 50% of diabetic cases in India show the presence of diabetes and HPTN [13,14]. Diabetes in other Asian countries such as Saudi Arabia (53%) [15,16], Jordan (72.4%) [17], Oman (21.5%), Turkey (32%), Bahrain (38%) and Taiwan (39%) [18-21] also shows a similar trend.

Epidemiological studies asserting incidence rates of T2DM and HPTN have been carried out in various sectors of Karnataka. In the rural population of Davanagiri, 18.3% of HPTN has been reported, where males show higher prevalence (19.1%) than females (17.5%) [26]. There is no known record of the prevalence of HPTN among T2DM or vice versa, implying how frequent HTN exacerbates T2D in Rural area of North Eastern Andhra Pradesh, India. At present, there are limited epidemiological studies enlightening the relationship between T2DM and HPTN in India. There is an ongoing debate regarding the consideration of high blood pressure over other metabolic components (conjointly involved in T2DM and HPTN), as a predictor of T2DM in Indians. we hypothesize that the risk of incidence of T2DM is higher in the subjects with HPTN. The present study aims to assess the prevalence of HPTN among T2DM subjects and its impact in the occurrence of T2DM in Paderu rural area population of Andhra Pradesh.

Materials and Methods

The present study was carried out in and around Rajahmundry city and Paderu rural area . The size of the sample was 1010. But those responded was 884 which including both the genders. The present study was carried out during 2010 to 2011 in both non-diabetes and diabetes patients without causing any mental destruction The study protocol was reviewed and approved human ethical committee of Andhra University, and also obtained the consents of the participant. This study was conducted with the help of skilled technicians. The subjects including 516 males and 368 females, aged between 20 - 70 years were selected for the study. Subjects with abnormal renal or other diseases were excluded. The glycemic condition was confirmed by OGTT test. Fasting was measured early in the morning and Postprandial plasma glucose was measured after 2 hours of administering 75-grams of glucose to the subjects (OGTT, WHO, 1999). Data was collected on standardized questionnaire that included personal information, life-style, habitual behaviors (smoking and alcohol intake), clinical history was studied for complications and blood pressure was recorded .

Anthropometry parameters included height, weight, waist and hip circumference were measured using digital weighing machine (Tanita Corporation, Tokyo, Japan) as per WHO international manual [24]. Biochemical parameters included Fasting plasma glucose (FPG), Glycated Haemoglobin (HbA1c), High-density lipoprotein (HDL), Low-density lipoprotein (LDL), Cholesterol (CHOL), Creatinine (CRE), Blood urea nitrogen (BUN) and

Postprandial glucose (PPG) were measured with Accu-Check of Germany make. Body mass index (BMI) was calculated as weight in kilograms divided by the squared value of height in meters (kg/m2). BMI was categorized as normal (<25 kg/m2), overweight (>25 and < 30 kg/m2), and obese (>30 kg/m2) [25]. Blood pressure (Systolic and Diastolic) of each subject was measured using a standardized sphygmomanometer (Elko, India), in supine position. An average of two readings of both systolic (SBP) and diastolic blood pressure (DBP) was taken. HPTN was defined following the criteria of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure [26]. Participants were divided (as per their baseline BP) into, normal (SBP < 120 mmHg and DBP < 80 mmHg), Pre-hypertensive (SBP 120 - 140 mmHg and DBP 80 - 90 mmHg) and Hypertensive (SBP > 140 mmHg and/ or DBP > 90 mmHg), or presently taking anti-hypertensive medication. Further, hypertensive (presently taking anti-hypertensive medication or/ and with a history of HPTN diagnosed by a medical physician) including the pre hypertensive were combined in one group. Self re-ported cases and individuals with FPG > 126 mg/dl and PGLU > 200 mg/dl were defined as diabetes [17]. Diabetics under treatment and long term management of blood glucose were defined as controlled diabetes with HbA1c values 6% - 8%. On the contrary above 8% were considered uncontrolled diabetes [18].

Statistical Analysis

The analysis has been carried out after segregating the cases and controls further into hypertensive and normal, resulting into four groups in total. The results have been reported as mean ± standard deviation. χ2-test was used to compare the proportion of the subjects between different variables. Logistic regression analysis was performed to assess the independent effect of hypertensive status on the odds of occurrence of diabetes, after adjusting for confounders. Statistical analyses were per-formed using SPSS version 12.0 software. All the reported P-values were two- tailed, and those less than 0.05 were considered statistically significant.

Results

Table 1 shows the distribution of HPTN with regard to gender, age groups, diabetes status and addiction habits (smoking and alcohol.) The overall prevalence rate of HPTN was found to be 57.5%, 24.00 % of male and 33.503 % in females. The intergroup difference is significant (P > 0.05). Among different age groups, the rate of HPTN increased with age from 20- 69 years and then gradually decreased in subjects of 70 years and above and was significant (P < 0.001). HPTN prevalent among smokers was significantly less than non- smokers , exsmokers showed the highest prevalence (P < 0.05). In alcoholics it was found to be insignificant. Obese subjects were observed to have significantly higher prevalence rate of HPTN (20.58%) than overweight (42.32%) and normal (37.10%) subjects. HPTN was found to be more prevalent (P < 0.001) among diabetics (57.5%) than non-diabetics (38.03%). This was further substantiated by the significantly (P < 0.001) higher prevalence rates among uncontrolled diabetes (51.7%) and controlled diabetes (37.28%) subjects than non-diabetic subjects (39.9%) as categorized by the HbA1c levels.

Table-1

Variables	Category			HPTN		total	
		N	%	N	%	N	
Diabetes status	Type 2 Diabetes	255	42.50	345	57.50	600	<0.006
	Non	176	61.97	108	38.03	284	
Sex	Female	99	45.62	144	24.00	243	0.006
	Male	156	47.27	201	33.50	357	
	20-29	22	8.63	20	5.80	42	<0.001
Age groups	30 - 39	20	7.84	28	8.12	50	
	40 - 49	45	17.65	69	20.00	144	
	50 - 59	54	21.18	75	21.74	139	
	60 - 69	60	23.53	85	24.64	165	
	70 - 79	54	21.18	68	19.71	132	
BMI groups	Normal (<25)	118	46.27	128	37.10	246	0.009
	Overweight (25 - 30)	79	30.98	146	42.32	255	
	Obese (>30)	58	22.75	71	20.58	129	0.03
Smoking	Yes	137	53.73	196	56.81	333	
	No	86	33.73	95	27.54	181	
	Quit	32	12.55	54	15.65	86	
Alcohol intake	Yes	98	38.43	173	50.14	271	
	No	110	43.14	138	40.00	248	
	Quit	47	18.43	34	9.86	81	
Glycated haemoglobin A1c	<6%	128	50.20	166	48.12	270	
	6% - 8%	87	34.12	133	38.55	211	
	>8%	40	15.69	46	13.33	89	

The variables are described in Table 2 after classifying the subjects into four groups based on clinical history of diabetes and/or HPTN. HPTN was more prevalent in subjects of the older age group, irrespective of the presence or absence of T2DM. Both diabetes normal and hypertensive subjects were observed to have a significantly higher waist circumference than non-diabetic normo-tensive subjects. Individuals affected by both of the mentioned disorders had higher BMI and CRE levels than normal controls. As anticipated, both systolic and diastolic blood pressure was higher among hypertensive groups than normotensive. Fasting glucose, postprandial glucose, glycated haemoglobin and triglyceride levels were significantly higher in the diabetes groups, irrespective of HPTN. On the contrary, HDL levels were found to be low in the diabetes subjects. Levels of BUN were found to be significantly higher in diabetes hypertensives when compared to diabetes non-hypertensives. CHO and LDL levels showed no significant difference between the groups.

Table 2. Characteristics of the subjects grouped based on presence or absence of diabetes and hypertension. Biomarker

Biomarker	Diabetic hypertensive	Non-Diabetic	Non diabetic hypertensive	Non diabetic normal tensive
	Mean ± S.D N = 153	Mean ± S.D N = 142	Mean ± S.D N = 83	Mean ± S.D N = 258
Age (years)	59.04 ± 10.50*#	54.26 ± 12.49*	56.34 ± 11.65*	48.33 ± 12.81
Waist (cm)	92.83 ± 11.45* ^	89.98 ± 12.51*	88.44 ± 11.18	86.21 ± 11.05
Body mass index (kg/m)2	27.37 ± 4.51*	26.04 ± 4.25	26.71 ± 5.18	25.48 ± 4.55
Systolic blood pressure (mmHg)	152.51 ± 15.68*#	120.86 ± 12.97^	153.88 ± 19.25*	110.87 ± 12.11
Diastolic blood pressure (mmHg)	92.48 ± 12.13*#	82.56 ± 10.79^	96.07 ± 11.71*	80.08 ± 9.93
Fasting glucose (mg/dl)	142.56 ± 59.19* ^	145.44 ± 58.93* ^	90.20 ± 11.17	88.45 ± 9.97
Postprandial glucose (mg/dl)	228.16 ± 97.34* ^	228.57 ± 93.62* ^	115.71 ± 24.45	109.39 ± 22.71
Triglyceride (mg/dl)	184.13 ±111.94* ^	186.65 ±105.48* ^	149.05 ± 85.89	143.86 ± 91.58
Cholesterol (mg/dl)	175.18 ± 45.78	174.06 ± 51.09	171.78 ± 49.75	168.58 ± 47.08
High density lipoprotein (mg/dl)	44.74 ± 9.95* ^	47.09 ± 10.72* ^	50.49 ± 7.95	50.08 ± 8.31
Low density lipoprotein (mg/dl)	101.79 ± 23.63	102.70 ± 22.15	100 ± 21.76	98.05 ± 20.42
Creatinine (mg/dl)	1.05 ± 0.49*	0.99 ± 0.32	0.98 ± 0.36	0.95 ± 0.32
Blood urea nitrogen (mg/dl)	10.30 ± 4.1#	9.12 ± 3	9.78 ± 3.24	9.43 ± 3.32
Glycated haemoglobin A1c (%)	7.45 ± 2.09* ^	7.25 ± 2.13* ^	5.11 ± 1.36	4.95 ± 1.06

Discussion:

Studies on co-occurrence diabetes and hypertension have not been reported in and around of Rajahmundry including rural areas. However, studies linking HPTN to T2DM in India are very few. As per Screening India's Twin Epidemic (SITE) study, the prevalence rate of the co-occurrence of HPTN and T2DM in individual of eight states was 20.6%, with 34.7% of T2DM and 46% of HPTN. In Karnataka, the frequency of co-occurrence of HPTN and T2DM is 17.4%, whereas HPTN and T2DM occur alone at 32.1% and 34.5% respectively [29]. In the present study, co-occurrence of HPTN and T2DM was observed to be 24.1% of the Rajahmundry population with a higher prevalence rate of HPTN (37.1%) and T2DM (46.4%) than reported by SITE study for the entire Karnataka population. Present study shows a higher rate of incidence when compared to Karnataka. The incidence of HPTN among T2DM patients in the present study population (51.9%) is comparable to T2DM incidence in Kashmir (42%) and varies from other populations of India [13-25]. The differences observed in the incidences of HPTN in T2DM among different populations can possibly be attributed to ethnicity, population dispersion, physical characteristics and the multiple definitions adopted for T2DM/ HPTN and closely related procedures in the previous studies.

Studies have shown that intensive blood sugar control is effective in reducing the risk of HPTN by approximately 25%. Our

findings are in conformity with earlier studies, where the incidence of HPTN among T2DM subjects having glycemic control (HbA1c < 8%) is lower than in uncontrolled group (HbA1c > 8%) [20, 21]. Customarily, hypersensitivity in diabetes advances with age as reported in other studies [22-25]. Contrastingly, we observed a lag in the occurrence of HPTN in subjects beyond the age of 70 years, which can be attributed to the lower levels of BMI. In accordance with earlier findings higher BMI group showed a high prevalence rate for HPTN [14-16]. Further, high prevalence of HPTN among ex-smokers projects the probable association of the disorder with the duration of addictive behaviors. An unusual trend has been reported in prior studies of higher prevalence of hypertensives amongst former smokers and non smokers than smokers which harmonize with our results [17,18]. The possible answer could be the unwillingness of individuals to disclose their addictive behavior and also occurrence of obese/overweight subjects under the smokers' category.

It has been established that co-existence of T2D and HTN accelerates the progression of metabolic abnormali- ties more than their independent outcomes. Hence, there is always a chance of significant variability in metabolic characteristics between individuals suffering independ- ently with both disorders or with the coexistence [19]. In our study the population is categorized into four groups (Non diabetes normotensive, Non diabetes hypertensive, diabetes normotensive and diabetes hypertensive) re- ferring to four conditions, with significant observed dif- ferences among the groups. Insulin resistance in T2D causes inhibition of lipolysis leading to hyperinsulinemia and elevated triglyceride [20]. Our findings are in agree- ment with the aforesaid inference, wherein elevated lev- els of fasting glucose, postprandial glucose, glycated haemoglobin, triglyceride levels of FPG, PPG, HbA1c, TRIG and low levels of HDL levels were observed in diabetes hypertensives and normotensive groups. Our finding is in concordance with earlier studies, suggesting the association of T2D with dyslipidemia, particularly with high triglycerides accompanied with a simultaneous decrease in HDL cholesterol [21]. Positive association between HTN and abnormal lipid profiles in rural popu-lation of Bagalkot in Karnataka [22] and among hospital patients have been reported in previous studies on Indian population [13,24].

Elevated BUN has been reported to be a marker for activating the sympathetic nervous system and an un-regulated rennin angiotensin system. Thus increased lev-els of BUN in T2D with HTN distinctly reveals the risk of renal and atherosclerotic complications in diabetes hypertensives than diabetes normotensive [15-19]. In the present study, the co-incidence of T2D and HTN as de-fined by higher BMI and CRE levels strengthens the no-tion that obesity and renal dysfunction are predictors of T2D associated with HTN.

Our study indicates that HTN plays a major role in the development of T2D, after the confounding effects of age, sex, BMI, glycemic index (FPG, PPG and HbA1c), lipid profile, CRE and other relevant factors had been adjusted. Our result concurs with the recent findings that aging, obesity, dysglyceamia and dyslipidemia co-exist with HTN and T2D [17,]. Studies reported a precise and prominent role of HTN in the prevalence

of T2D with crude relative risks of 2.34 relatively lower than the ratio obtained in our study. This evidently suggests that Mysore population is at a higher risk of T2D due to HTN. Previous studies on Asian populations proposed that baseline hyperglycemia and BMI are potential covariates determining the association of HTN with T2D. Thus, baseline HTN may be a potential predictor for incident diabetes, if the onset of diabetes is defined using pa-rameters like FPG and PPG levels [21]. However, it has been concluded that obesity and metabolic syndrome does not explain the entire association between BP and incidence of T2D [23]. Hence, besides BMI, lipid profile and Glycemic index, we included CRE and BUN into these models. Accumulation of BUN and CRE is a direct indicator of renal dysfunction. Thus higher levels of these are observed in hypertensives, more precisely in untreated hypertensives and diabetes nephropathy cases [24]. Furthermore, it has been reported that renal failure rate is two to three times higher in patients of diabetes hypertensives than in non diabetes hypertensives [15]. Therefore, inclusion of these predictors can ascertain the association between T2D and HTN. Lack of correction for the predictor variables related to renal dysfunction can be one of the reasons for discrepancies in the earlier studies [20, 22].

Conclusion

The high prevalence rate of T2D and HTN is major concerns in Mysore population. HTN plays a key role in the progression of T2D and is associated with vascular complications. Among hypertensives, BMI, Glycemic index, lipid profile and kidney dysfunction, markers are potential predictors of T2D. The assessment of nephropathic markers besides analyzing metabolic components and blood pressure management is better approaches to pre-vent the risk of development of T2D in hypertensives.

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