

## ASSOCIATION OF HYPERTENSION AND NON-INSULIN-DEPENDENT DIABETES MELLITUS IN THE SAUDI POPULATION

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**Background:** Saudi Arabia has a high prevalence of diabetes mellitus (DM). Several studies have shown that hypertension (HT) occurs frequently in obese individuals. This study was conducted to determine the prevalence of HT in Saudi diabetic patients.

**Subjects and Methods:** A total of 13,519 nondiabetic and 1286 diabetic adult subjects diagnosed during the National Program for the Study of DM, in which household screening was carried out, were included in the study. The diagnosis of DM and HT was based on the criteria of the World Health Organization.

**Results:** From the total group, the prevalence of HT in nondiabetic males and females was 4.48% and 2.8%, respectively, while it was 11.44% and 15.98% in the diabetic males and females, respectively. The subjects were classified according to the province to which they belonged, and the prevalence of HT was calculated in the diabetic and nondiabetic group. In the Central, Eastern and Western Provinces, female diabetics had a significantly higher HT prevalence compared to male diabetics, however, in the Southern and Northern Provinces, the prevalence rate was almost the same. In all provinces the increase in prevalence of HT in diabetics was significantly higher in the females compared to the males.

**Conclusion:** Since HT prevalence increases significantly in diabetics, and this association leads to several cardiovascular complications, it is necessary to adopt measures for the control of DM and HT in the Saudi population.

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**Key Words:** Diabetes mellitus, hypertension, cardiovascular disease, multifactorial disorders, insulin resistance.

Diabetes mellitus (DM) and hypertension (HT) are both multifactorial disorders which occur at a higher prevalence in the older age group and result from both genetic and environmental etiological factors.<sup>1-3</sup> DM is by far the most common metabolic disorder in many populations of the world.<sup>4</sup> Similarly, HT is considered to be one of the most common causes of morbidity and mortality affecting mankind.<sup>5</sup> In Saudi Arabia, our extensive studies and those of other researchers have shown that DM occurs at a high prevalence in the different provinces and increases significantly with age.<sup>6,7</sup> Hypertension has also been shown to be prevalent in all provinces of the country.<sup>8-10</sup>

Several studies conducted in different ethnic groups show a close association between HT and DM, where the prevalence of HT is significantly higher in the patients with noninsulin-dependent diabetes mellitus (NIDDM or type II DM).<sup>11-15</sup> Both systolic and diastolic HT have been reported, and conclusive evidence indicates that the link

between diabetes and essential HT is hyperinsulinemia.<sup>16-20</sup> Diabetes mellitus and HT are interrelated diseases that strongly predispose people to atherosclerotic cardiovascular disease, and hence have been referred to as "the bad companions."<sup>13</sup> Interestingly, in a study on newly diagnosed diabetes patients, no significant elevation of HT was identified in NIDDM patients.<sup>21</sup> In addition, significant ethnic differences have been reported in the nature and severity of complications and prevalence of HT in patients with NIDDM.<sup>18,22-26</sup>

We conducted this study in different provinces of Saudi Arabia in an attempt to investigate the prevalence of HT in diabetic Saudis.

### Subjects and Methods

This study was carried out during the National Screening Program for DM in five different provinces of Saudi Arabia. The screening was carried out as a household screening program. In each province, areas were randomly selected and divided into sectors. In each sector, every tenth street was selected, and on every street every tenth house was enrolled for screening. The selected household was contacted and details of the study were explained to the occupants and their cooperation requested. Only families who volunteered were included (over 95% of total). Those who declined were replaced by other randomly selected families from the same locality.

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TABLE 1. Prevalence of hypertension in total nondiabetic and diabetic Saudi males and females.

Sex	Total no.		Nondiabetic		Diabetic		$\chi^2*$	P-value	
	investigated	Total No.	HT	Prevalence of HT (%)	Total No.	HT			Prevalence of HT (%)
Male	6225	5552	249	4.48	673	77	11.44	57.2	<0.0001
Female	8580	7967	222	2.8	613	98	15.98	272.6	<0.0001
Total	14,805	13,519	471	3.5	1286	175	13.6	286.0	<0.0001

\*Significance of the difference in prevalence of HT in diabetic and nondiabetic groups.

TABLE 2. Prevalence of hypertension in nondiabetic and diabetic Saudi males and females in different provinces.

Province	Sex	Nondiabetic			Diabetic			$\chi^2*$	P-value
		No. investigated	No. HT	Prevalence of HT (%)	No. investigated	HT	Prevalence of HT (%)		
Central	M	1716	58	3.38	197	15	7.61**	7.52	<0.05
	F	2402	66	2.75	214	32	14.95**	77.9	<0.0001
Eastern	M	228	28	12.28	23	4	13.39**	0.138	0.7
	F	328	28	8.54	32	11	34.38**	7.5	<0.0001
Southern	M	1747	54	3.09	179	21	11.73	30.1	<0.0001
	F	2617	52	1.99	151	17	11.26	46.7	<0.0001
Northern	M	1036	52	5.02	91	16	17.58	21.2	<0.0001
	F	1439	48	3.33	79	14	17.72	35.97	<0.0001
Western	M	825	57	6.91	183	21	11.48**	3.76	<0.052
	F	1181	28	2.37	137	24	17.52**	70.4	<0.0001

\*Significance of the difference in prevalence of HT in the diabetic and nondiabetic groups; \*\*the difference in prevalence of HT in males and females in the same province is statistically significant.

All family members were instructed to remain in an overnight fasting state on a mutually agreed day for the visit of the research team. An early morning visit was made and essential information was recorded. Systolic and diastolic blood pressure were recorded using the standard method. The recording was made when the individual was in a sitting position. The diastolic blood pressure was taken at phase 5 (disappearance of Korotkoff's sounds). Two readings of blood pressure were recorded at 3- and 5-minute intervals and the second of the two readings was recorded on the form. Fasting blood sample was extracted by venipuncture from all adults and children. However, children were excluded from this study. Blood glucose was estimated immediately using Answer™ Blood Glucosemeter (Coulter-Wallace International Distribution, USA) and Answer™ test strips impregnated with glucose oxidase/peroxidase. The glucometer was regularly standardized against an autoanalyzer (American Monitor "Parallel"). Each adult individual was given orally a load of 75 g glucose in 200-300 mL of water, while children were given 1.75 g glucose in water/kg body weight, up to a maximum of 75 g. A two-hour postglucose load blood sample was taken and immediately analyzed using the glucometer.

The diagnosis of DM was based on WHO criteria<sup>27,28</sup> as follows: fasting venous blood glucose  $\geq 6.7$  mmol/L ( $>120$  mg/dL) and/or two-hour postglucose load  $\geq 10.0$  mmol/L ( $>180$  mg/dL). Differentiation between IDDM and NIDDM was made based on age of onset and mode of treatment. For people with IDDM, the disease presented at a younger age ( $<25$  years) and required continuous use of insulin following diagnosis to maintain their glucose level in the normal range. Diagnosis of HT was also based on WHO criteria.<sup>29</sup> Values of systolic pressure  $\geq 140$  mm Hg and/or

diastolic pressure  $\geq 90$  mm Hg were considered hypertensive. Individuals on antihypertensive drugs were included as hypertensive. Chi-squared analysis using 2x2 contingency tables were used to compare any two groups and  $P < 0.05$  was considered statistically significant.

## Results

The final study group included a total of 14,805 subjects (male, 6225 [42.0%], age range 14-69 years; mean, 27.8 years; BMI,  $26.3 \pm 5.65$  kg/m<sup>2</sup>; female, 8580 [58.0%], age range 14-69 years; mean, 27.3 years; BMI,  $26.8 \pm 5.6$  kg/m<sup>2</sup>). The total number of diabetic subjects (excluding IDDM subjects) was 1286, comprising 673 males (52.3%) and 613 females (47.7%), and were grouped as hypertensive and normal.

The total number of NIDDM and nondiabetic males and females screened and the number and prevalence of HT in both groups are presented in Table 1. The overall prevalence of HT in the nondiabetic group was 4.48% in males compared to 2.8% in females, while in the diabetic group the prevalence of HT was 11.44% in males and 15.98% in females. The difference in the prevalence of HT in the two groups was statistically significant ( $P < 0.05$ ) in both males and females.

The total population was classified according to the province from which they originated, and the prevalence of HT in both diabetics and nondiabetics was calculated in each group (Table 2). Among the nondiabetics, males showed a higher prevalence of HT compared to the females in all provinces of Saudi Arabia. In the diabetic group, the prevalence of HT was significantly higher in the females in the Central, Eastern and Western Provinces, while in the Southern and Northern Provinces,

the prevalence was similar in both males and females. In all areas, the prevalence of HT was significantly higher in the diabetic group compared to the nondiabetic group ( $P < 0.01$ ).

### Discussion

Saudi Arabia has undergone significant epidemiological transformation over the past two or three decades. This has resulted in modification of the lifestyle to a more sedentary way of living, with considerable reduction in the extent of physical activity, increase in intake of "fast foods" and elevation of stress-related work and other activities. Females are particularly more prone to sedentary life, and due to the climatic conditions, i.e., high temperatures, particularly during the summer months, outdoor life is significantly reduced. This has caused the precipitation of several multifactorial traits both in males and females. Our extensive studies during a national project on DM have shown a high prevalence of NIDDM, obesity, overweight and HT in the Saudis.<sup>6-9,30</sup> This study on a group of diabetic and nondiabetic Saudis has revealed that the prevalence of HT is significantly higher in the male and female diabetics in comparison to nondiabetics. In males, the prevalence of HT is increased almost 2.6 times in the diabetic group, while in the female diabetics, the prevalence of HT is increased almost 5.7 times. This increase in the prevalence of HT among the diabetics occurs in all areas of Saudi Arabia. These findings are in line with those reported in the literature.

Several studies show close association between HT and DM.<sup>11-15</sup> In a study in France, Marre et al. reported HT in almost one-third of diabetic cases.<sup>31</sup> Among adult Afro-Americans, elevation of blood pressure is significantly higher in individuals with impaired glucose tolerance and diabetes than in nondiabetics. Among Indians of Guadeloupe, who have an especially high prevalence of NIDDM, mean arterial systolic and diastolic pressures were significantly higher in 86 diabetics compared to 86 age- and sex-matched nondiabetics.<sup>32</sup> In a recent study from Bahrain, HT was reported in 21%, 31% and 38% of normal, impaired glucose tolerance, and diabetic individuals, respectively.<sup>26</sup> In another study, the prevalence of HT was reported to be almost 50% in NIDDM patients.<sup>20</sup>

The occurrence of HT in diabetic patients increases significantly the risk of coronary artery disease, mortality and nephropathy.<sup>33-36</sup> It is of significance that BP is controlled in diabetic patients. Physiological maneuvers, such as calorie and salt restriction and regular physical exercise, are shown to improve tissue sensitivity to insulin and hence lower blood pressure both in normotensive and hypertensive diabetics.<sup>16</sup>

In Saudi Arabia, the prevalence of DM is high,<sup>6,7</sup> and with the increase in prevalence of HT in diabetics, as shown in this study, the associated morbidity and complications are expected to increase. Hence, control of DM and HT by appropriate methods, particularly dietary restriction of calories and sodium, and regular physical

exercise, must be stressed in order to decrease both the prevalence of HT and NIDDM. This requires extensive awareness programs for the general public aimed at augmenting prevention programs. Of interest is the prospect of introduction of presymptomatic diagnosis of susceptible individuals using genetic markers, where it is expected to play an essential role in the control and prevention of noncommunicable diseases. If this becomes a practical approach, the prevention of the complications will be of appreciable benefit to those prone to DM and HT.

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