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Diabetes and Hypertension in a Santhal Tribe in Bangladesh: A Population Based Study

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Abstract

BACKGROUND: Santhal (Santals) tribe is one of the oldest and largest aboriginal pre Aryan populations in India and Bangladesh. There was no published report on the prevalence of diabetes and hypertension. OBJECTIVE: To determine the prevalence of type 2 diabetes mellitus (T2DM) and hypertension in a Santhal tribe of Bangladesh. RESEARCH DESIGN AND METHODS: Eight villages inhabited largely by Santhal tribe were purposively selected. All Santhals aged 20 years or more were considered eligible and enlisted for the study. Investigations included socio-demographic information (age, sex, education, income), clinical history (general illness), anthropometry (height, weight, waist-girth, hip-girth) and blood pressure. Body mass index (BMI) and waist-to-hip ration (WHR) were calculated. Blood samples were collected for fasting plasma glucose (FPG), total cholesterol (Chol), triglycerides (TG), urea and creatinine. RESULTS: Thirteen hundred eligible Santhals were enlisted. Of them, 1049 (80.7%) participated in the study. The male and female participants were 40% and 60%, respectively. The prevalence of T2DM was 0.6% and hyperglycemia (FPG > 5.5 mmol/l) was 10.0%. The prevalence of systolic hypertension (sHTN) was 24.4% and diastolic hypertension (dHTN) was 24.6%. Compared with the males the females had significantly higher prevalence of sHTN (OR, 2.20 with 95% CI, 1.62 - 3.02) and dHTN (OR, 1.81 with CI, 1.34 - 2.0); whereas, the prevalence of T2DM and IFG did not differ. Regarding obesity 45% of the participants had BMI < 18.5 and only 5% had BMI > 23.1. Logistic regression estimated that the increasing age, female sex, higher FPG (>5.5 mmol/l) and higher Chol (>160 mg/dl) had independent risk for sHTN and dHTN. CONCLUSIONS: The Santhals had less risk for diabetes but increased risk for hypertension. The Santhal females had excess risk of hypertension. Advancing age, female

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sex, hyperglycemia and hypercholesterolemia were found to have significant risk for hypertension. Obesity had no effect on diabetes or hypertension. High dietary salt intake among Santhals might have contributed to the development of hypertension. Further study may confirm the study findings and to understand why this tribe is less susceptible to diabetes and more to hypertension.

Keywords

Santhal, Obesity, Diabetes, Hypertension, Lipids

1. Introduction

The increasing trend of Type2 diabetes is common in the developing nations and most common in the Southeast Asian countries [1]. The tribal or aboriginal populations also showed an increase of diabetes worldwide. High prevalence of diabetes was reported among the Native Americans [2]-[6]. The aborigines of Australia had increased prevalence of diabetes and metabolic syndrome leading to diabetic complications like nephropathy [7]. In Africa, the prevalence of diabetes was found high among Danagla community of northern Sudan [8]. In Asia too, an increased prevalence of diabetes, obesity and hypertension was reported among Bedouin origin in the United Arab Emirates [9] and among the Aborigines in Taiwan [10]. One of the tribes in Bangladesh also had higher prevalence of diabetes as compared with Bangladeshi native rural people [11]. Santhal (Santals) tribe is the third largest tribe of India and Bangladesh in Asia [12]. It is thought to be the oldest indigenous tribe that belongs to the Pre Aryan period [12]-[14]. They are mostly found scattered in the states of West Bengal, Bihar, Orissa, Jharkhand and Assam in India, and in the northern-west of Bangladesh. Notwithstanding Santhals are one of the largest and the oldest aboriginal tribes in India and in Bangladesh there has been no known information about the prevalence of diabetes or hypertension in this tribe. This study addressed the prevalence of diabetes and hypertension among the Santhals.

2. Research Design

The research proposal was duly approved by the Ethical Review Committee of *Bangladesh Diabetic Samity* (*BADAS*); previously known as *Diabetic Association of Bangladesh* (*DAB*).

2.1. The Study Area

We purposively selected eight villages mostly inhabited by Santhal in Manda Thana under the district of Naogaon adjacent to Rajshahi. It is a 14-hour journey by bus from Dhaka. We conducted the study in the month of December2008 through February 2009.

The selected villages of Santhals were made habitable by their forefathers. The livelihood of their ancestors was hunting and gathering in the forest. Subsequently, their primitive occupation changed to agriculture with gradual reclamation of livable and cultivable land from hilly forest. The ancestors of Santhals were Pre-Aryan and/or Proto-Australoids [12] [13]. The Santhals have been living in this area for generations. Most of them are landless poor dependent on agrarian works for their livelihood.

To begin with the study we consulted the local leaders of Santhal community and the elected members of the Union Council, a Local Government Body. They agreed to participate. The young Santhals volunteered making list of the eligible participants from the Santhal communities. All members of each Santhal family aged 20 years or more were considered eligible. The field workers had considerable discussion with the enlisted participants about the objectives and the details of investigations.

The investigation procedure included: a) interviewing; b) clinical examination; c) anthropometry (height, weight, waist-girth and hip-girth); d) resting blood pressure and e) fasting blood sample. Each participant was interviewed about 1) socio-economic condition e.g. housing, sanitation, education, occupation, physical activity, family income; and 2) family history of chronic illness based on available medical reports and/or verbal autopsy.

The local leaders, the volunteers, and the participants opined that it would be convenient for them to attend

investigations in two sessions—I) afternoon session: interviewing, anthropometry and clinical examination while spending at leisure, and II) following morning session: they would come with overnight fast for fasting blood samples and resting blood pressure before starting their daily work.

2.2. Data Collection

The trained field workers started interviewing session at afternoon for age, sex, education, annual family income and current illness. Known family history of diabetes, hypertension, stroke and coronary heart disease were also noted. Anthropometry included weight, height, waist- and hip-girth. Then, each participant was referred to an adjacent physician's desk for both general and systemic examination for clinical assessment. Each participant was registered with an identification number (ID No). Then s/he was advised to attend the same location in the next morning with an overnight fast for measuring blood pressure and giving fasting blood sample.

Measurements of height, weight, and waist and hip girth were taken with light clothes and without shoes. The weighing tools were calibrated daily by known standard weight. For height, the subject stood in erect posture vertically with the occiput, back, hip, and heels touching the wall behind while gazing horizontally in front and keeping the tragus and lateral orbital margin in the same horizontal plane. Waist girth was measured by placing a plastic tape horizontally mid-way between 12th rib and iliac crest in the mid-axillary line. Similarly, hip was measured by taking the extreme end posteriorly and the symphysis pubis anteriorly. Blood pressure was taken after 10 min rest with standard cuffs for adult, fitted with mercury sphygmomanometer. All types of physical activities-household (e.g. washing, cooking, cleaning, gardening) and outdoor (e.g. ploughing, digging, crop-carrying, harvesting, boat-rowing, manual irrigation etc) were graded according to the intensity and duration of work, from heavy, moderate and mild or sedentary type, based on an equivalent walk of >90 min, 60 - 90 min and <60 min/24hours, respectively [15].

Five ml of venous blood was taken for fasting plasma glucose, total cholesterol, HDL cholesterol, and triglycerides (TG). We kept generator standby for continuous supply of electricity for the required laboratory investigation. We estimated plasma glucose by the glucose oxidase (enzymatic oxidation) method (GOD/PAP Kit; Randox, Antrim, U.K.) using the auto-analyzer Screen Master-3000 (B.S. Biochemical Analyzer, Arezzo, Italy). We used diagnostic criteria of American Diabetes Association [16]. Systolic and diastolic hypertension were taken as ≥135 and ≥85 mmHg, respectively.

2.3. Statistical Analysis

The comparisons of characteristics (mean with standard deviation) were shown between men and women and between subjects with and without hypertension. The prevalence rates of hypertension (sHTN and dHTN) and diabetes were shown in percentages. The Chi sq test estimated the association of diabetes and hypertension with biophysical risk factors like age, sex, obesity etc. As the prevalence of diabetes was found very low, IFG was taken together to get the total prevalence of hyperglycemia for a meaningful comparison between men and women. Logistic regression was used to quantify the risk factors, which were selected stepwise in different steps taking systolic hypertension (sHTN) as a dependent variable; covariates were sex, age, WHR, FPG, Chol in forward conditional method. All statistical tests were considered significant at a level of ≤5%. SPSS version 10.05 was used.

3. Results

A total of 1300 Santhals of age 20 years or more from 8 selected villages were enlisted. Of them, 1049 (80.7%) responded. The male and females participants were 40% and 60%, respectively.

Most of the participants were from poor social class. Seventy-five percent had daily per capita earning of USD 0.33 or less; only 35% had access to water-seal latrine and the rest used bore-hole or trench latrine. Of them, 86% were illiterate, 13.8% could write his name and address and a total of 5 participants had 10 years schooling. As regards housing, 94% had single hut covered with corrugated tin shed and the rest were thatched. It was a harvesting period when sedentary or mild type of physical activities was found only in 1.3%, moderate activity in 8.8% and heavy physical activity in 85.5%. Family history of diabetes, hypertension, sudden death (suspected coronary heart disease) and paralysis were reported in 2.1%, 8.5%, 1.4% and 5.2%, respectively. The Santhal people experienced high prevalence of joint swelling (suspected Arthritis 21.6%) and epigastric pain related

to meal (suspected peptic ulcer disease 16.5%). Regarding drug history, about 67.8% of the participants never used any medicine. Of the female participants of reproductive age, 10.2% reported using oral contraceptive pills.

Clinical examination revealed that 43.5% had mild to moderate and 1.4% had severe degree of anemia. Palpably enlarged liver was found in 1.8%. Two had detectable jaundice with tender and enlarged liver diagnosed as possible viral hepatitis. Two participants had visible goiter and one had dependent pitting edema.

The bio-physical characteristics were compared between male and female participants (**Table 1**). The mean values with standard deviations (SD) of age, FPG and TG did not differ. Regarding obesity, compared with the females the males were significantly more obese ($p < 0.001$ for both BMI & WHR). In contrast, the means (SD) of SBP, DBP and T-chol were found significantly higher among female than among males.

The characteristics were also compared between hypertensive and non-hypertensive Santhals (**Table 2**). Compared with the non-hypertensive the hypertensive Santhals had significantly higher means (SD) of age, SBP, DBP, FPG, T-chol, TG and creatinine (for all, $p < 0.001$); whereas, BMI and WHR did not differ.

The prevalence of DM was 0.6% and hyperglycemia (FPG > 5.5 mmol/l) was 10.0% and the prevalence did not differ between men and women. The prevalence of both hypertension (sHTN & dHTN) and hyperglycemia according to sex were shown in **Table 3**. The prevalence of sHTN was 24.4% and dHTN was 24.6%. Compared with the male the female Santhals had significantly higher prevalence of sHTN (16.2 v. 29.9%; OR 2.20, 95% CI, 1.62 - 3.02). Likewise, the prevalence of dHTN was also significantly higher among female than the male participants.

We used logistic regression to quantify the individual effect of sex, age, WHR, FPG and T-chol on systolic hypertension as a dependent variable in forward conditional method (**Table 4**). These variables were selected because of having significant associations with SBP estimated by partial correlation controlling for age and sex (correlation table not shown). The logistic regression, at the fourth stage, retained the significant effect of female sex (OR 2.43, 95% CI, 1.68 - 3.52), hyperglycemia (OR 3.2, 95% CI, 1.99 - 5.14) and hypercholesterolemia (OR 1.90, 95% CI, 1.35 - 2.67). For age, higher the age more was the risk (age 31 - 45 y: OR 1.78, 95% CI, 1.15 - 2.76; age > 45: OR 5.93, 95% CI, 3.85 - 9.11). Obesity (WHR > 0.85) had no effect for hypertension in the Santhal population.

4. Discussion

This study appears to be the first of its kind that addressed not only the prevalence of diabetes and hypertension in one of the largest and the oldest aboriginal tribe in India and in Bangladesh but also to report overall health situation and socio-economic backgrounds of Santhal population. It was possible because of the sincere cooperation made by the Santhals in all investigation steps. The response rate was more than 80%. The young Santhal volunteers helped not only preparing the list of the participants but also organizing the entire study—like selecting the sites of investigation in each village, informing the participants about place, date and time, making arrangement

Table 1. Comparison of characteristics between men (n = 419) and women (n = 630).

	Men		Women		
Variables	Mean	SD	Mean	SD	*p
Age (y)	39.8	16.2	38.8	13.5	*ns*
BMI	19.3	2.1	18.6	2.6	<0.001
WHR	0.88	0.05	0.83	0.07	<0.001
WHtR	0.44	0.04	0.44	0.05	*ns*
SBP (mmHg)	122	19	130	23.1	<0.001
DBP (mmHg)	78.7	11.3	81.1	11.8	=0.001
FPG (mmol/L)	4.41	0.83	4.45	0.91	*ns*
T-chol (mg/dl)	145	30	155	30	<0.001
Triglycerides (mg/dl)	96	37	99	41	*ns*
Urea (mg/dL)	28.4	9.5	26.9	10.9	=0.03
Creatinine (mg/dl)	1.1	0.25	0.95	0.33	<0.001

BMI: body mass index; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio; SD: standard deviation; FPG: fasting plasma glucose; SBP, DBP: systolic, diastolic blood pressure; T-chol: total cholesterol; *p: after unpaired t-test (men v. women); ns: not significant.

Table 2. Comparison of characteristics between subjects with and without systolic hypertension.

	Non hypertensive SBP < 135 mmHg (n = 778)		Hypertensive SBP ≥ 135 mmHg (n = 255)		*p
	Mean	SD	Mean	SD	
Age (y)	36.3	12.6	48.3	16.9	<0.001
BMI	18.9	2.3	18.8	2.93	*ns*
WHR	0.85	0.06	0.86	0.07	*ns*
WHtR	0.44	0.04	0.45	0.06	<0.001
SBP (mmHg)	117	9	157	22	<0.001
DBP (mmHg)	76	8	93	11	<0.001
FPG (mmol/L)	4.29	0.80	4.87	0.97	<0.001
T-chol (mg/dl)	149	29	160	31	<0.001
Triglycerides (mg/dl)	96	38	106	424	= 0.001
Urea (mg/dL)	26.9	8.6	28.8	14. 6	=0.020
Creatinine (mg/dl)	1.00	0.23	1.09	0.49	<0.001

BMI: body mass index; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio; SD: standard deviation; FPG: fasting plasma glucose; SBP, DBP: systolic, diastolic blood pressure; T-chol: total cholesterol; *p: after unpaired t-test (non-hypertensive v. hypertensive); ns: not significant.

Table 3. Prevalence of hypertension (systolic & diastolic: sHTN & dHTN) and IFG + T2DM.

	n	sHTN	OR [95% CI]	dHTN	OR [95% CI]	n	IFG +DM FPG > 5.5 mmol/l	OR [95% CI]
Men	421	68 (16.2)		77 (18.3)		366	38 (10.4)	
Women	626	187 (29.9)	2.20 [1.62 - 3.02]	181 (28.9)	1.81 [1.34 - 2.46]	577	63 (10.9)	1.11 [0.69 - 1.62]
Total	1047	255 (24.4)		258 (24.6)		943	94 (10.0)	

Parenthesis ( ) indicates percentages; [ ] indicates 95% confidence interval after odds ratio (men v. women) OR: odds ratio.

of transports and so on. There was an effort to avoid bias in selection of a representative sample of the tribes. Considering our logistic support, communication and language gap we had no option other than to trust the list of participants made by the volunteers. This may be the limitation of this study. The other limitations may also be noted that clinical findings of illness (anemia, jaundice, edema, goiter, hepatomegaly) could not be confirmed by laboratory investigation.

There are substantial reports that indicate an increased prevalence of diabetes and/or hypertension among the indigenous or tribal or aboriginal populations [3]-[8]. One of the tribal populations of Bangladesh also showed higher prevalence of diabetes compared to rural Bangladeshis [11]. Obviously, it was hypothesized; the Santhal tribe also might have increased prevalence of diabetes. On the contrary, the Santhals had the lowest prevalence of T2DM (0.6%) as compared to that of rural (4.3%), Khagrachari Tribe (6.6%) and urban (11.2%) populations of Bangladesh [11] [15] [17]. There has been no available published report on the prevalence of diabetes or hypertension in this pre-Aryan Santhal tribe. So, the findings of this study could not be compared. Very low prevalence of diabetes in this population may possibly be due to their exposure to heavy physical activity and lack of obesity. Of the Santhal participants, 85.5% were exposed to heavy physical activity, and 90% of them had BMI < 21.9 and WHR < 0.93. Thus, the two most known risk factors for diabetes (physical inactivity and obesity) were found non-existent in the Santhal people. There may be some genetic factor of Santhal origin that have protective role against diabetes or still some other unidentified factor(s) that kept them least prone to develop diabetes. Further study is needed to clarify these unknown factors for better understanding of pathogenesis of diabetes.

About one-fourth of the Santhal people had either systolic (24.4%) or diastolic (24.6%) hypertension. This estimate appears to be higher than a comparable population-based study in a rural native population of age 20 years or more, which estimated 14.9% for systolic and 9.1% for diastolic hypertension [18]. This is a striking observation. It was difficult to explain why there was an increased prevalence of hypertension despite the

Table 4. Logistic regression—risk factors selected stepwise in different steps taking systolic hypertension (SHTN) as a dependent variable; covariates are sex, age, WHR, FPG, Chol in forward conditional method.

Risk factors	OR	95% CI	p
Step 1			
Age tertile (y)			
Age ≤ 30	1	-	
Age 31 - 45	1.91	1.25 - 2.92	=0.003
Age > 45	6.16	4.07 - 9.32	<0.001
Step 2			
Sex (m = 1, f = 2)	2.56	1.79 - 3.67	<0.001
Age tertile (y)			
Age ≤ 30	1	-	
Age 31 - 45	1.92	1.25 - 2.95	=0.003
Age > 45	6.60	4.32 - 10.07	<0.001
Step 3			
Sex (m = 1, f = 2)	2.56	1.78 - 3.69	<0.001
Age tertile (y)			
Age ≤ 30	1	-	
Age 31 - 45	1.85	1.20 - 2.86	=0.006
Age > 45	6.14	4.00 - 9.43	<0.001
FPG (mmol/L)			
(<5.6 = 1, ≥5.6 = 2)	3.26	2.04 - 5.21	<0.001
Step 4			
Sex (m = 1, f = 2)	2.43	1.68 - 3.52	<0.001
Age tertile (y)			
Age ≤ 30	1	-	
Age 31 - 45	1.78	1.15 - 2.76	=0.010
Age > 45	5.93	3.85 - 9.11	<0.001
FPG (mmol/L)			
(<5.6 = 1, ≥5.6 = 2)	3.20	1.99 - 5.14	<0.001
T-chol (mg /dl)			
(<161 = 1, ≥161 = 2)	1.90	1.35 - 2.67	<0.001

STEPS: Age tertile was entered on step 1, sex on step 2, FPG on step 3 and T-chol on step 4. WHR was found not significant and not included in the eas its association was found. †: risk factors in quintile: BMI: body mass index (wt kg/ht m sq), Quintile-1 is taken as reference category. §: Physical activities: equivalent to "X" min walk/24 hour; excluded from Model 2, 3 & 4; BMI excluded Model 4: OR: odds ratio, CI: confidence interval.

absence of two known risk factors e.g. physical inactivity and obesity. To quantify the risks for hypertension, logistic regression finally, retained the significant effect of advancing age, female sex, hyperglycemia and hypercholesterolemia; whereas, BMI and WHR had no effect. Again, these findings remained unclear. Possibly, increasing age interacted with hyperglycemia and hypercholesterolemia in female Santhals might have influenced to develop hypertension.

Other possible explanation of hypertension in this population may be their dietary habit. Extensive interview revealed that these hard working people used to take large amount of rice, the cheapest food, to meet their calorie need for their subsistence. They could afford neither fat nor protein, nor even vegetable. They just had to depend simply on common salt and chilies. Thus, high salt intake was found common. When the hypertensive subjects were advised "reducing salt in their diet"—their single question was "Is it possible to take rice without salt?" True indeed, even when the cheapest vegetable curry could not be made accessible, salt was the only alternative for them. So, increased amount of sodium intake might be causally associated with hypertension. High dietary sodium in the heritability of non-modulating essential hypertension has been reported [19]. The Santhal aborigines might have inherited such non-modulating subsets, which needs further investigations for confirmation.

5. Conclusion

The Santhal people were found less prone to develop diabetes but very much susceptible to hypertension and the female Santhals had excess risk of hypertension. Advancing age, female sex, hyperglycemia and hypercholesterolemia were found to have significant risk for hypertension. Obesity was proved to have risk neither for diabetes nor for hypertension. High dietary salt intake might have contributed to the development of hypertension. Further study may be undertaken for confirmation of the study findings.

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Abbreviations

BMI: body mass index (wt in kg/ht in m.sq.);
BP: blood pressure (SBP & DBP = systolic & diastolic BP);
CI: confidence interval;
DM: Type 2 diabetes;
FPG: fasting plasma glucose; hyperglycemia (FPG ≥ 5.5 mmol/l);
HTN: hypertension (sHTN & dHTN = systolic & diastolic HTN);
IFG: impaired fasting glucose;
SD: standard deviation;
T-chol: total cholesterol;
TG: triglycerides;
WHR: waist-to-hip ratio.