HIGH PREVALENCE OF TYPE 2 DIABETES MELLITUS IN XAVANTE INDIANS FROM MATO GROSSO, BRAZIL

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Objective: To estimate the prevalence of diabetes, hypertension, obesity, and describe demographic, anthropometric and medical characteristics, in a genetically distinct population: the Brazilian Xavante Indians.

Design: Population-based survey carried out among 948 Xavante from Mato Grosso, Brazil. Fasting and 2-hour after 75 g glucose capillary glycemia were measured by a portable glucometer (HemoCue® Glucose201+). Diabetes was defined according to WHO criteria. Anthropometric data and medical characteristics were measured, and fat mass (%) was evaluated using bioelectrical impedance. Blood pressure was measured by an automated device (OMRON 742INTC®), and hypertension was defined according to WHO criteria.

Results: Age-adjusted prevalence rates with 95% confidence intervals were diabetes: 28.2% (25.3–31.1) in general, 18.4% (14.9–22.2) in men and 40.6% (36.2–45.1) in women ($P<.001$); impaired glucose tolerance: 32.3% (20.5–26.0) in general, 29.7% (25.4–33.9) in men and 34.4% (30.2–38.8) in women ($P>.05$); hypertension: 17.5% (15.1–19.9) in general. Obesity was found in 50.8% of the individuals. Fat mass (%) was associated with diabetes in men ($P<.05$) and women ($P<.05$). Thigh circumference and waist/thigh ratio were lower in those with diabetes, in men and women ($P<.001$).

Conclusions: The high prevalence of diabetes and obesity in Xavante is likely related to their recent change in food habits and physical activities. Our results should raise awareness about the magnitude of this health problem and also indicate that it could increase dramatically in the future if no preventive actions are adopted. (*Ethn Dis.* 2014;24[1]:35–40)

Key Words: Diabetes Mellitus, Hypertension, Obesity, Xavante

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INTRODUCTION

Populations from some ethnic groups are at the greatest risk for type 2 diabetes mellitus, particularly the indigenous populations in the Americas.[1] Reports of diabetes in the Brazilian indigenous populations were scarce, however, increased frequencies of diabetes among the Xavante have been reported in the last decade by doctors who have been providing assistance at Indians reservations.[2] These Indians seek medical assistance due to symptoms of metabolic decompensation and chronic diabetes complications. The interaction between genetic susceptibility and changes in life style is considered the main reason for the outbreak of the diabetes epidemic in this population.[3,4]

Xavante speak a language within the Jê linguistic group and live in a broad region of the Brazilian plateau known as cerrado. In the past, these Indians were semi-nomadic and lived by hunting and gathering fruits, and practicing rudimentary agriculture. They have had permanent contact with civilization for the last 60 years;[5,6] the contact led to significant changes in the lives of Xavante. They became more sedentary and modified their traditional diet by incorporating new foods obtained in nearby cities or through food baskets donated by governmental agencies. Thus, important changes have been observed in the nutritional and health profile of this population, including diseases, such as diabetes, that were previously unknown to them.[5,6]

The health changes observed among the Xavante motivated our study, which aimed to estimate the prevalence of diabetes, hypertension, and overweight among adult individuals, and describe some demographic, anthropometric and medical characteristics of the participants. A better understanding of the health profile of this population may help contribute to the control of these diseases and improve the population's health.

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METHODS

A population-based survey was carried out among Xavante Indians aged ≥20 years from the Sangradouro/Volta Grande and São Marcos reservations located in Mato Grosso, Brazil.[7] According to the Brazilian 2010 Census,[8] the total population living in Sangradouro/Volta Grande was 882 individuals (623 adults aged ≥20) in 31 villages, and São Marcos with 3,138 individuals (1,588 adults aged ≥20) in 28 villages. During the field work, these reservations were visited ten times from 2008 through 2012. The study was approved by the Brazilian National Indian

Foundation Agency, responsible for indigenous protection, and the Brazilian National Ethics Committee of the Ministry of Health, in accordance with the Declaration of Helsinki. Local indigenous leaders were contacted and provided consent for the study, and participants signed an informed consent written in Portuguese. For the ones who were illiterate, fingerprints were used to document their approval. All adult individuals from the two reservations were invited to participate. During the field visits, the research team was accompanied by indigenous health workers with basic training in nursing who facilitated the contact with the Indians. Besides the work related to this study, the research team assisted the Indians who presented health problems and provided local service or referrals to nearby towns with more resources when necessary.

Data Collection

The collected information included name, age, sex, names of parents, marital status, and prior health problems including diabetes and hypertension. The anthropometric measurements including weight, height, waist circumference (abdominal circumference measured at the middle distance between the edge of the last rib and iliac crest), hip circumference (hip circumference measured below the iliac crest), and thigh circumference (circumference measured midway between the iliac crest and knee) were evaluated. The following ratios were calculated: Body mass index (BMI), waist circumference/hip circumference, waist circumference/thigh circumference, and waist circumference/height. The amount of fat and thin mass was evaluated using bioelectrical impedance equipment (BIA-Biodynamics® 450 model). Blood pressure was measured in the left arm from seated patients, after 5 minutes of rest, using the OMRON HEM-742INTC® equipment. Blood pressure was measured three times and the average of the last two readings was taken as final. Hypertension was defined as systolic blood pressure (SBP) ≥140 mm Hg or diastolic blood pressure (DBP) ≥90 mm Hg, according to WHO criteria.[9] Capillary glycemia was measured by a portable glucometer (HemoCue® Glucose201$^+$ HemoCue AB, Angelholm, Sweden). Blood samples were collected from individuals fasting from 8 to 10 hours through vein puncture in the forearm using vacuum, sterile, and disposable collectors (Vacuotainer®); 30 mL of blood were collected for laboratory tests. Individuals with glucose <200 mg/dL and not taking oral anti-diabetics or insulin were submitted to a 75 g of anhydrous glucose load (Glutol®); capillary glucose was determined two hours after this intake. Urine samples were collected for microalbuminuria and creatinine determination. Blood and urine samples were processed, separated into aliquots, and stored at −20°C before transportation to the city of São Paulo for laboratory analyses. The diagnosis of diabetes (DM) was made if the individual had routine use of oral anti-diabetics or insulin, or casual capillary glycemia ≥200 mg/dL, or two hours after 75 g glucose load glycemia ≥200 mg/dL. Individuals with 2 hour capillary glycemia between 140–199 mg/dL were classified as having impaired glucose tolerance (IGT), according to WHO criteria.[10] Obesity was defined in individuals with BMI ≥30 kg/m^2.

Statistical Analysis

General prevalence rates and prevalence rates within age groups (20–29, 30–39, 40–49, 50–59, and ≥60 years) and sex were calculated. The age standardization was made by the direct method[11] using the Brazilian population as the standard, according to the Brazilian 2010 Census.[8] The prevalence of DM, IGT and normal glucose tolerance (NGT) were calculated among groups of sex, age, BMI categories. The differences in the prevalence among groups were tested using the two-sample proportion test. The mean and standard deviation of weight, height, waist, hip, and thigh circumferences, waist/hip, waist/thigh, and waist/height ratios, and % of fat mass were calculated among groups of sex and glucose tolerance, and two-sample mean comparison test and the one-way ANOVA test was used to verify differences in the mean among these groups. The significance level was established at 5%. The statistical analyses were performed using the Stata® 9.1 software (StataCorp., Texas, USA, 1990523476 License-Department of Social Medicine FMRP-USP).

RESULTS

A total of 948 individuals of both sexes (463 men, 485 women) were evaluated, 318 (77.9% of available adults) at Sangradouro/Volta Grande (162 men, 156 women) and 630 (39.7% of available adults) at São Marcos (301 men, 329 women). The crude and age-adjusted prevalence of hypertension was 17.5% (15.1–19.9) and 17.2% (14.8–19.7) in general, and no sex difference was observed (P>.05).

Table 1 shows the participants according to demographic, anthropometric and medical characteristics by sex. The mean of weight, height, fat mass (%) thigh circumference, SBP and DBP were higher in men than in women (P<.001).

Table 2 shows the prevalence of DM, IGT and NGT by sex and age group. The prevalence of DM in women was higher than men (P<.05) in all age groups. In men, the prevalence of DM increased with age up to age 40–49 years, and in women the prevalence increased up to age 50–59 years. The overall crude and age-adjusted prevalence of DM was 25.9% (23.2–28.9) and 28.3% (25.3–31.1); for IGT was 33.4% (30.4–36.5) and 32.3% (20.5–26.0).

Table 3 shows the prevalence of DM, IGT and NGT according to

Table 1. Participants according to demographic, anthropometric and medical characteristics, by sex, Xavante Brazilian Indians, 2012[a]

Variables	Men, *n*=463	Women, *n*=485	Total, *N*=948	*P*[b]
Age, yrs	43.5 (19.2)	42.6 (19.4)	43.0 (19.3)	NS
Weight, kg	83.8 (14.2)	74.1 (14.8)	78.8 (15.3)	<.001
Height, m	1.67 (.05)	1.54 (.05)	1.60 (.08)	<.001
BMI, kg/m^2	29.8 (4.5)	30.8 (5.6)	30.3 (5.1)	NS
Fat mass, %	22.7 (6.1)	32.9 (6.6)	27.9 (8.1)	<.001
Waist circumference, cm	95.9 (10.3)	98.7 (11.1)	97.3 (10.8)	NS
Hip circumference, cm	99.8 (8.2)	102.7 (11.0)	101.3 (9.8)	NS
Thigh circumference, cm	56.4 (5.7)	53.8 (7.3)	55.1 (6.7)	<.001
Waist to hip ratio	.95 (.04)	.96 (.05)	.96 (.05)	NS
Waist to thigh ratio	1.70 (.15)	1.84 (.17)	1.77 (.17)	NS
Waist to height ratio	.57 (.05)	.63 (.06)	.60 (.07)	NS
SBP, mm Hg	125.0 (16.2)	119.6 (18.3)	122.3 (17.5)	<.001
DBP, mm Hg	74.0 (11.0)	71.4 (10.5)	72.7 (10.8)	<.001
Fast glycemia, mg/dL	142.0 (97.3)	164.9 (113.9)	153.7 (106.7)	NS
HbA1c, %	6.89 (2.46)	7.75 (2.94)	7.35 (2.76)	NS
Total cholesterol, mg/dL	145.8 (42.7)	146.8 (43.2)	146.3 (43.0)	NS
HDL-C, mg/dL	37.1 (7.4)	40.5 (8.0)	38.8 (7.9)	NS
LDL-C, mg/dL	70.8 (25.9)	69.6 (23.2)	70.2 (24.5)	NS
VLDL-C, mg/dL	32.7 (14.8)	33.0 (16.9)	32.9 (15.9)	NS
Triglycerides, mg/dL	201.0 (160.7)	203.4 (237.8)	202.3 (203.7)	NS

[a] Data are mean (SD) unless indicated otherwise.
[b] Two-sample mean comparison test.
NS, non significant.

BMI. The prevalence of DM in women was higher than in men, in all classes of BMI ($P<.05$). No difference was observed in prevalence of DM according to BMI classes ($P>.05$). The prevalence of obesity was 50.8% in general (48.8% in men, 52.8% in women, data not shown).

Table 4 shows anthropometric and medical characteristics according to diagnosis of DM, IGT and NGT. In men, the means of age, fat mass (%), waist to hip ratio, waist to thigh ratio, DBP, fasting glycemia, HbA1c and triglycerides were higher in participants with DM ($P<.05$); thigh circumference was higher in those with IGT and NGT ($P<.05$). In women, the means of age, waist to thigh ratio, SBP, DBP, fasting glycemia, HbA1c, total cholesterol, VLDL-c and triglycerides were higher in participants with DM ($P<.05$). Fat mass (%) was higher in those with DM and IGT ($P<.05$); thigh circumference was higher in IGT and NGT ($P<.05$).

DISCUSSION

The prevalence of diabetes observed among the Xavante (25.9%) was high when compared to the general Brazilian

Table 2. Prevalence (%) of diabetes mellitus, impaired glucose tolerance, and normal glucose tolerance, by sex and age group, Xavante Brazilian Indians, 2012

	Men, *n*=463			Women, *n*=485			Total, *N*=948		
Glucose tolerance Age group, yrs.	DM *n*=77	IGT *n*=141	NGT *n*=245	DM *n*=169	IGT *n*=176	NGT *n*=140	DM *n*=246	IGT *n*=317	NGT *n*=385
20–29	4.2[a]	24.6	71.2	14.1[b]	35.2	50.7	9.6	30.4	60.0
30–39	15.2[a]	31.7[a]	53.1	31.1[b]	43.9[b]	25.0	22.7	37.5	39.8
40–49	32.5[a]	27.3	40.2	55.5[b]	28.9	15.6	45.0	28.1	26.9
50–59	27.3[a]	27.3	40.4	63.6[b]	27.3	9.1	36.4	27.3	36.3
≥60	17.8[a]	40.0	42.2	46.4[b]	35.4	18.2	33.5	37.5	29.0
Total Crude	16.6[a]	30.5	52.9	34.8[b]	36.3	28.9	25.9	33.4	40.7
Age-adjusted	18.4[a]	29.7	51.9	40.6[b]	34.4	25.0	28.3	32.3	39.4

[a, b] Two-sample proportion test; a<b ($P<.05$).
DM, diabetes mellitus; IGT, impaired glucose tolerance; NGT, normal glucose tolerance.

Table 3. Prevalence (%) of diabetes mellitus, impaired glucose tolerance, and normal glucose tolerance, by sex and categories of body mass index, Xavante Brazilian Indians, 2012

Glucose tolerance	Men, *n*=463			Women, *n*=485			Total, *N*=948		
BMI (kg/m^2)	DM *n*=77	IGT *n*=141	NGT *n*=245	DM *n*=169	IGT *n*=176	NGT *n*=140	DM *n*=246	IGT *n*=317	NGT *n*=385
<25	14.3[a]	28.6	57.1	36.8[b]	30.9	32.3	25.4	29.7	44.9
25–29	15.6[a]	28.1	56.3	37.3[b]	32.9	29.8	26.2	30.5	43.3
≥30	18.1[a]	32.7	49.2	32.8[b]	39.8	27.4	25.9	36.5	37.6
Total	16.6[a]	30.5	52.9	34.8[b]	36.3	28.9	25.9	33.4	40.7

[a, b] Two-sample proportion test; a<b ($P<.05$).
DM, diabetes mellitus; IGT, impaired glucose tolerance; NGT, normal glucose tolerance.

Table 4. Anthropometric and medical characteristics according to diagnosis of diabetes mellitus, impaired glucose tolerance, and normal glucose tolerance, by sex, Xavante Brazilian Indians, 2012[a]

Variables	DM	IGT	NGT	P^b
Men, *n* (%)	77 (16.6)	141 (30.4)	245 (53.0)	
Age, yrs	48.5 (17.2)	45.8 (20.1)	40.6 (18.9)	<.05
Weight, kg	83.0 (14.0)	84.9 (15.7)	83.4 (13.2)	NS
Height, m	1.66 (.05)	1.66 (.05)	1.67 (.04)	NS
BMI, kg/m^2	29.8 (4.8)	30.4 (4.8)	29.5 (4.2)	NS
Fat mass, %	23.6 (6.4)	23.5 (6.2)	21.9 (5.9)	<.05
Waist circumference, cm	97.2 (11.1)	97.1 (10.8)	94.8 (9.7)	NS
Hip circumference, cm	99.5 (8.4)	100.9 (8.7)	99.4 (7.9)	NS
Thigh circumference, cm	54.4 (6.5)	56.8 (5.9)	56.8 (5.3)	<.05
Waist to hip ratio	.97 (.04)	.96 (.04)	.95 (.05)	<.05
Waist to thigh ratio	1.79 (.14)	1.71 (.14)	1.67 (.15)	<.001
SBP, mm Hg	123.8 (20.1)	127.1 (16.4)	124.2 (14.6)	NS
DBP, mm Hg	75.5 (12.4)	75.4 (11.8)	72.7 (9.9)	<.05
Fast glycemia, mg/dL	286.8 (172.7)	119.7 (21.6)	109.3 (20.0)	<.001
HbA1c, %	10.2 (3.5)	6.0 (.5)	5.8 (.4)	<.001
Total cholesterol, mg/dL	148.6 (37.1)	142.2 (36.6)	147.0 (47.5)	NS
HDL-C, mg/dL	37.2 (6.4)	37.8 (7.5)	36.6 (7.7)	NS
LDL-C, mg/dL	68.4 (30.1)	67.8 (25.1)	73.2 (25.0)	NS
VLDL-C, mg/dL	35.6 (14.7)	32.4 (15.0)	32.8 (14.8)	NS
Triglycerides, mg/dL	257.7 (191.9)	190.5 (150.1)	189.3 (152.6)	<.05
Women, *n* (%)	169 (34.8)	176 (36.3)	140 (28.9)	
Age, yrs	48.8 (18.4)	42.1 (19.3)	35.8 (18.6)	<.001
Weight, kg	73.6 (15.4)	75.3 (14.1)	73.1 (15.1)	NS
Height, m	1.54 (.05)	1.54 (.05)	1.55 (.05)	NS
BMI, kg/m^2	30.7 (6.0)	31.4 (5.3)	31.7 (6.3)	NS
Fat mass, %	33.3 (6.7)	33.5 (6.7)	21.9 (5.9)	<.05
Waist circumference, cm	99.2 (11.8)	99.4 (10.6)	97.4 (11.0)	NS
Hip circumference, cm	103.0 (12.2)	103.3 (10.1)	101.6 (10.5)	NS
Thigh circumference, cm	52.3 (7.5)	54.9 (7.3)	54.3 (6.7)	<.05
Waist to hip ratio	.96 (.05)	.96 (.04)	.95 (.04)	<.05
Waist to thigh ratio	1.90 (.17)	1.82 (.16)	1.80 (.15)	<.001
SBP, mm Hg	123.9 (21.9)	120.5 (16.8)	113.5 (13.2)	<.001
DBP, mm Hg	73.6 (11.6)	72.1 (9.6)	68.0 (9.4)	<.001
Fast glycemia, mg/dL	260.7 (150.2)	117.1 (19.8)	109.5 (17.8)	<.001
HbA1c, %	9.9 (3.3)	6.1 (.9)	5.9 (.5)	<.001
Total cholesterol, mg/dL	159.4 (58.7)	141.1 (30.7)	138.9 (29.2)	<.001
HDL-C, mg/dL)	40.3 (8.0)	40.6 (7.9)	40.8 (8.3)	NS
LDL-C, mg/dL	68.8 (24.8)	68.5 (23.8)	71.9 (20.5)	NS
VLDL-C, mg/dL	42.4 (17.7)	30.5 (15.0)	26.2 (13.5)	<.001
Triglycerides, mg/dL	299.0 (363.7)	169.1 (105.6)	130.9 (67.6)	<.001

[a] Data are mean (SD) unless indicated otherwise.
[b] One way ANOVA.
DM, diabetes mellitus; IGT, impaired glucose tolerance; NGT, normal glucose tolerance; NS, non-significant.

population (7.6%)[12] and Japanese Brazilians from Mombuca-SP (10.7%);[13] however, the prevalence of diabetes in Xavante women (34.8%) is similar to the prevalence found among Japanese Brazilians of Bauru-SP (30.9%),[14] and indigenous groups, such as the Pima from Arizona (38.0%).[15] The prevalence of hypertension in Xavante is below the average values observed in the general adult Brazilian population (20%).[16] Some of the anthropometric measurements that assess abdominal obesity were associated with DM and IGT among the Xavante: fat mass, waist to hip ratio, and waist to thigh ratio in men, and waist to thigh ratio in women. The observed prevalence of obesity in Xavante is actually very high and was rare when they were living in traditional conditions.[5,6] Greater access to food in recent history eliminated their need to move through their territory, and they became more sedentary, and obesity gradually became a health problem.[17] Industrialized sugar and farmed animals, were unknown to the Xavante in the past, and they began to consume these foods after contact with colonizing fronts of the Brazilian society. These changes in their diet are similar to what occurred among Japanese descendants, who migrated to the Americas and adopted Western customs into their eating habits, resulting in a dramatically increased prevalence of diabetes.[14] Similarly, the Pima Indians,[15] and the Nauruan[18] population that currently present high prevalence of diabetes were free of diabetes before changing eating and living habits. These changes observed in Xavante mainly affected domestic activities, and women were most affected in their daily life activities and became more sedentary. Men decreased their physical activity in a smaller proportion compared to women. Physical activities related to sports and rituals remained.

The means of fasting glycemia, HbA1c and triglycerides observed in Xavante were higher in DM and IGT individuals, showing changes in glucose metabolism. The means of total cholesterol, LDL-c and HDL-c were characteristically low. The metabolic disease observed in Native Americans associated with low HDL-c levels, obesity and type 2 diabetes, is possibly related to ABCA1 gene variant positive selection.[19]

The prevalence of hypertension in Xavante is below the average values observed in the general adult Brazilian population (20%).[16]

The lower number of individuals in the age group 50 to 59 years, when analyzing the age distribution of the examined population, is noteworthy. They correspond to individuals who were born during the period when the Xavante were settling in the Sangradouro/Volta Grande reservation (1957) or transferring from the North of Mato Grosso to the São Marcos (1966) reservation.[6] It is possible that during this period of transition and adjustments, a high mortality rate might have occurred mainly among infants, combined with a low natality rate. During the course of the Xavante history[5] the population has been highly isolated and only a low level of admixture has occurred.[4] Many consanguineous unions may have occurred within the community, given the small size of the population of certain isolated groups, and this might have contributed to the selection of individuals more susceptible to some metabolic diseases such as diabetes, which results from the interaction between genetic and environmental factors.[3]

The frequency of IGT in individuals from the youngest age group (20–29 years) was strikingly high, particularly among women, indicating that the magnitude of this diabetic epidemic will grow in the coming years if no intervention takes place to modify the current Xavante life style.

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