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Excess weight and associated factors among Xavante Indigenous adults, Central Brazil

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Abstract *Considered an important public health problem among Indigenous peoples in Brazil, obesity is a risk factor for Noncommunicable Diseases (NCDs) and conditions. The present study aimed to describe the occurrence of excess weight, obesity, and associated factors in Xavante Indigenous adults, through a nutritional survey carried out in the population ≥ 15 years of age living in the Pimentel Barbosa and Wedezé Indigenous Lands, Mato Grosso, Central Brazil, during the period of June to August 2011. Eight of the 10 villages in the territory were investigated. Anthropometric, bioimpedance and socioeconomic data were collected. This study counted on 495 participants, corresponding to 94.1% of the target population. The prevalence of overweight and obesity was 65.9% (male: 63.2%; female: 68.6%) and 19.8% (male: 21.3%; female: 18.2%), respectively. In the multiple regression model, the prevalence of excess weight was higher among women, in higher age groups and education levels, in individuals living in group 2 of the villages, and in households with low consumption of farmed foods. An increase in the age group aged 20 to 49 years and in individuals living in households with a low consumption of food from hunting, fishing, and gathering presented the highest prevalence of obesity.*

Key words *Health of Indigenous peoples, Obesity, Epidemiology, Xavante*

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Introduction

In recent decades, changes in health standards of populations have been reported globally, defined by an expressive increase in Noncommunicable Diseases (NCDs) and their risk factors. To a great extent, these changes can be attributed to the processes of industrialization and urbanization, to population aging, to changes in behavior, as well as in means of subsistence. Such changes appear in various manners, and it is common to find, in developing countries and among populations in unfavorable economic conditions, the presence of a double burden of disease, defined by the persistence of infectious, parasitic, and deficiency diseases, along with the emergence of NCDs[1,2]. Among these NCDs, excess weight and obesity emerge as important public health issues, since they are considered to be risk factors for other types of NCDs, such as diabetes, hypertension, and some kinds of cancer[3-5].

In Brazil, studies show evidence of disparity in the distribution of excess weight, obesity, and other NCDs, something that has been associated with markers of social inequality, such as income, education, race, and ethnicity, for instance[6]. Among Indigenous populations, both in Brazil and internationally, excess weight and obesity are emerging illnesses. Such a profile is characterized by the history of contact of Indigenous peoples with the surrounding society, as well as by intrusion and loss of land, and is related to changes in the means of subsistence, together with dependency on the regional market[7-12].

The impact of this interaction appears as changes in the lifestyle of Indigenous populations, such as modifications in food consumption patterns, an increase in the intake of ultra-processed foods that are rich in sodium, and a decrease in the practice of physical activities. Nationally, such patterns were documented in the First National Health and Nutrition Survey of Indigenous Peoples (1st NHNSIP), which estimated a prevalences of 46.2% for excess weight and 15.8% for obesity among Indigenous women of reproductive age, with considerable regional inequalities[7], given that the highest prevalence was found in the Midwest region (excess weight: 52.8%; obesity: 17.2%) and South/Southeast (excess weight: 54.7%; obesity: 22.6%), while the lowest prevalence was found in the North region (excess weight: 31.2%; obesity: 6.1%)[7]. Several studies conducted in specific Indigenous communities reinforce the existence of a high prevalence of excess weight and obesity in Indigenous populations throughout the country[10,13-15].

The Xavante people, inhabiting areas of the state of Mato Grosso, in the Midwest region of Brazil, is one of the Indigenous populations in which studies have indicated the health effects caused by the invasion of their land by the demographic frontier since the middle of last century. Studies that indicated those transformations also verified an increase in NCDs[8,10,16-18]. Considering the context of changes in health standards of the Xavante people, the present study investigated the prevalence of excess weight and obesity among individuals aged 15 years and older, who reside in the Indigenous lands of Pimentel Barbosa and Wedezé. This study also provides evidence of specific socioeconomic and demographic factors associated with these populations.

Population and methodology

This study is part of an inquiry about health and nutritional conditions conducted with the Xavante population of the Indigenous Lands (IL) of Pimentel Barbosa and Wedezé, in the state of Mato Grosso, Central Brazil, which took place from June to August 2011. The present analysis focused on the population segment of ≥ 15 years of age, residing in eight of the ten eligible villages – Pimentel Barbosa, Eténhiritipá, Caçula, Wedezé, Asereré, Canoa, Reata, and Tanguro, which have 82.4% of the population of the IL studied. The community leaders of two of the villages did not accept the participation of their communities in the inquiry.

The sample began with 559 Indigenous individuals in the age group considered for the study. Among those, 33 women (7.8%) were pregnant or were unsure if they were pregnant, and were therefore excluded from the analyses. That resulted in a final contingent of 526 individuals who met the study's inclusion criteria.

The team of field researchers had professionals in nursing, nutrition, and anthropology, trained and enabled to apply the questionnaire and to handle the instruments of the inquiry. The questionnaires were based on those used by the NHNSIP[19], adapted for the cultural specificities of the Xavante and complemented by additional issues of interest, such as oral health. To do so, home interviews were conducted with heads of family or other adult representatives of the family, discussing the conditions of sanitation and housing, manners of food acquisition, and socioeconomic profile. The individual interviews covered education level, reproductive and health history, access to healthcare services, and current

state of health. Anthropometric measurements of blood pressure, casual blood glucose and hemoglobin level were also taken.

Anthropometric and socioeconomic data

Height was measured in an erect position, with a portable Seca anthropometer, model 216 (Hamburg, Germany), and registered with 0.1 cm precision. Body weight was measured with a portable Seca digital scale, model 770 (Hamburg, Germany), with a maximum capacity of 150 kg and 100 g precision. Both measures, height and weight, were taken of all of the participants that were physically able, according to the recommendations by Lohman *et al.*[20] To conduct the anthropometric measurements, the participants were asked to wear light clothes and to be barefoot.

The body mass index (BMI) was calculated based on the weight and height variables, by the formula weight/height^2, and the cutoff points for normal weight, overweight, and obesity followed the guidelines set forth by the World Health Organization[21]. For the participants aged 14 to 19 years, the study adopted the cutoff points proposed by Onis[22].

Socioeconomic indicators

The following demographic and socioeconomic indicators were used: sex, age (age group), household per capita income (calculated by dividing the total income by the number of residents in the household), education, owned household goods, and food consumption.

Education was measured in years of study, completed with approval, distributed in the following manner; Unschooled (never attended school), 1 to 8 years of Primary school, 1 to 3 years of High School and/or 1 to 5 periods in the Haiyô project (training of Indigenous teachers in High School – a partnership between the State Secretary of Education, the National Foundation for Indigenous peoples (FUNAI), and the National Health Foundation (*Fundação Nacional de Saúde* – FUNASA). However, the periods considered in that project were calculated with the equivalence of two periods of the Haiyô project, for one year of High School, since each period in the project lasts an average of 2 to 3 months. For analysis purposes, we used the indicator in a categorized manner (unschooled, 1st to 4th grade, 5th to 8th grade, and High School/Haiyô).

The indicator of owned goods (household goods) was calculated based on a report of durable goods present in the household, according to a list of goods based on previous studies[10]. The main components analysis was conducted with 20 goods in order to obtain an index of owned goods capable of discriminating the purchasing power of the families[23]. The values in the matrix, of the correlations between the variables, range from -0.133, for the correlation between car and gas stove, up to 0.896, for the correlation between television and DVD player. The Kaiser-Meyer-Olkin score reached 0.644, exceeding the minimum value of 0.60 recommended for the conduction of this type of analysis. The eingenvalue of the first component in the multivariate analysis was 4.316, representing 21.6% of the total variability of the data set. The second component had an eingenvalue of 54.0% lower than the first (11.8% of the total variability).

The items which stood out in the first component were television, DVD, parabolic antenna, digital cameras, generator, and loudspeakers. Only this component was used in the definition of socioeconomic indicator, because it showed more power of explanation of variability. The value of the index of owned goods for each family is the result of the sum of the contribution of each item (generated by the main components analysis) multiplied by the quantity of such goods present in the household. Next, the indicator was divided in tertiles, based on the distribution of the values among the households, resulting in the levels that were considered to classify each household as low, medium, or high. The values of this indicator ranged between -1.084 and 4.417 and had, as cutoff points, the values of -0.683 and 0.302, respectively.

The variable number of residents in the household was used as a characteristic of the household, classified in three categories: 1 to 9 residents, 10 to 19 residents, and 20 to 28 residents, given that 28 was the highest number found.

Household food consumption pattern

To estimate food consumption in the households, the study investigated frequency of consumption of foods acquired through the following categories of production: domestic agricultural and livestock farming; gathering, fishing and hunting; and goods purchased in a town. For each of the categories, the residents of the household were asked about their typical frequency of consumption throughout the year.

This variable was used to characterize the economic insertion of the household in terms of the source of the food, and did not focus on the quantification of food consumption or individual nutrition. The foods detailed in the instrument contemplated all of the foods and food categories typically consumed by the Xavante from the villages that were part of the study. The instrument included 15 items from agriculture and livestock farming, such as wild rice, Xavante corn, etc., and 17 industrialized foods acquired by purchase, such as industrialized rice, coffee, sugar, cooking oil, among others. For each of the foods, the participants were asked about the frequency of consumption in the household, and the answers were classified as "never or rarely", "only sometimes or only at specific times", and "frequently or every day". The main components analysis was conducted with each one of these groups of food frequency, which were denominated as "agriculture or livestock farming", "hunting or gathering", and "purchasing".

The variable "group of villages" categorizes the participating villages in three groups, considering their territorial history, according to criteria proposed by Arantes *et al.*[24]. The first group included the villages of Pimentel Barbosa and Etênhiritipá, founded in 1970 and 2006, respectively. This group was more isolated and located in an area of preserved Cerrado. The second group was formed by the Caçula village, originated from the Pimentel Barbosa village in the 1980's, and two small villages, originated from the Caçula village in the early 2000s (Canoa and Wedezé). This group inhabited a flooded area next to the Mortes river. The third group had the villages of Tanguro, separated from Pimentel Barbosa in the 1980's, and two small villages originated from Tanguru in the early 2000s (Asereré and Reata). This group was located near a town, an interstate highway, and farms. To preserve confidentiality, we did not provide specific results for individual villages.

Statistical analysis

The descriptive analysis was conducted by the calculation of averages, of standard deviation, minimum and maximum values for anthropometric variables, socioeconomic scores, food consumption scores, and according to age group, sex, and group of villages. To evaluate the difference between proportions, the chi-square test was conducted. To verify differences in the averages of the anthropometric variables between sexes, the Student's t test was used.

The correlation between variables was analyzed by means of the Pearson correlation coefficient in bivariate analyses, testing the statistical significance by using the two-tailed test. We also calculated the prevalence of excess weight and obesity, according to sex, age, and socioeconomic stratum and according to indicators of BMI.

Next, we analyzed the measures of association between each variable of interest and the excess weight and obesity outcomes, by means of crude prevalence, considering a 95% confidence interval (95%CI). Chi-square tests for linear trends were conducted to evaluate the differences between the proportions and between categories of the variables of interest. The prevalence of excess weight and of obesity was calculated by groups of villages, sex, age group, number of residents in the household, owned household goods, and frequencies of household food consumption.

The multivariate analysis followed a logistic regression with robust variance adjustment for dichotomous outcomes (yes and no) for excess weight and obesity. The initial step in the analysis was to select variables for inclusion in the multivariate regression. For that purpose, univariate regression was conducted for each investigated variable separately with one of the dependent variables (excess weight or obesity), considering a p-value of 0.20 for the selection of variables to be included in the following phase. Next, all of the variables selected in the previous phase were included in the multivariate logistic regression, once again selecting those that remained with a level of statistical significance $p < 0.20$ by mutual adjustment. The variables selected in the previous phase were part of the procedure of logistic regression, by using the *stepwise backward* method for selection of variables in the final model, maintaining only those with adjusted OR and respective 95%CI with a significance level of a $p < 0.05$.

The statistical analyses were conducted using the IBM SPSS Statistics for Windows program, version 20.0. (Armonk, NY, USA).

Ethical considerations

The study conducted with the Xavante population followed all of the norms for research established by the Declaration of Helsinki and by the International Ethical Directives from the CIOMS. The protocol of the study was approved by the research ethic committee of the Escola Nacional de Saúde Pública and by the National Research Ethics commission (protocol

no. 2500202987/2010-14). The National Indigenous Foundation (*Fundação Nacional do **Índio*** – FUNAI) granted permission to conduct field research in federal Indigenous lands. All of the participants or their guardians were allowed to withdraw from participation at any moment. The analyses presented here are part of the doctoral dissertation of the main author of the article (FGT).

Results

Of the 526 Indigenous individuals eligible for this study, 31 were absent from the villages when measures were taken for weight and height. Therefore, our analysis was based on data from 495 individuals (Male: 253, 51.1%; Female: 242, 48.9%), corresponding to 94.1% of the population ≥ 15 years of age and of both sexes.

Table 1 presents the descriptive statistics of the anthropometric variables and socioeconomic indicators. The average age of the population was 34.3 years (SD:18.8), being 33.1 years (SD:18.1) for men and 35.5 years (SD:19.5) for women, with no significant statistical difference between the sexes. The weight and height averages presented statistical significance for the t test of difference in averages between the sexes, showing higher weight and height for men.

Among the villages that participated in the study, those with the highest number of individuals were Pimentel Barbosa (30.5%), Etênhiritipá (26.1%), and Caçula (21.0%). A higher proportion of female individuals was found in the unschooled stratum (39.3%) and in the 1st to 4th grade stratum (36.,0%), meanwhile the frequency of males is higher in the stratum with an education level of 5th to 8th grade (50.0%). In relation to household per capita income, most individuals earned between R$ 55.00 and R$ 109.99 (45.9%), with similar values for both sexes (Table 2).

Table 3 presents the prevalence of excess weight and of obesity according to socio-demographic and economic variables. There are statistically significant differences in the prevalence of excess weight between the categories of age group and frequency of consumption of foods produced by hunting/gathering and agriculture and livestock farming, given that the prevalence was higher for the intermediate age group and for the lower levels of food consumption in these standards. There were statistically significant differences in the prevalence of obesity among the categories of the variables of age group, education, owned household goods and frequency of consumption of foods from hunting/gathering, with a higher prevalence found in the intermediate age group, in the higher levels of education, in the higher levels of owned household goods, and in the low level of consumption of foods from hunting/gathering.

In the final multiple regression model, excess weight remained associated, with statistical significance, with sex, group of villages, age group, education, and agriculture/livestock farming. The chances of being excess weight were 63% higher among women when compared to men. The age groups 20 to 49 years and 50 years of age and older had 4.9-fold and 2.7-fold higher chances of being excess weight, when compared to the age group of 15 to 19 years. The categories of 1st to 4th grade and High School education or Haiyô presented an adjusted OR of 2.63 and 3.15, respectively, when compared to the unschooled individuals. Residing in the second group of villages resulted in a 42% lower chance of being excess weight as compared to residing in the first group of villages.

In the final multiple regression model, obesity only remained associated with statistical significance in the variables of age group and hunting/gathering. Being 20 to 49 years of age corresponded to a 11.1% higher chance of having obesity than that of individuals aged 15 to 20 years. Residing in a household that presents a medium frequency of hunting/gathering resulted in a 52% lower chance of having obesity when compared with those with a low level of consumption of foods produced by hunting/gathering (Table 4).

Discussion

The health of the Xavante has been the object of investigations conducted since the 1960's with the purpose of characterizing their profile of health and morbidity-mortality. Since then, studies have investigated aspects that are connected directly or indirectly with health, such as genetic, demographic, anthropological, and epidemiological studies[8,16-18,25-29]. The Pimentel Barbosa and Etênhiritipá villages were the objective of many of those studies[8,18], but the other villages belonging to the Pimentel Barbosa IL have rarely been investigated. Our study was the first of its kind to report epidemiological data related to health from nearly all of the individuals residing in the IL of Pimentel Barbosa and Wedezé, the latter having only recently been established[30].

Table 1. Descriptive statistics for age, anthropometric variables, per capita income and food consumption indicators for Xavante people, aged 15 years and over. Central Brazil, 2011.

Variable/Sex	n	Min	Max	P25	Median	P75	Average	SD	p-value*
Age									
Male	253	15.0	100.9	20.0	27.0	38.8	33.1	18.1	
Female	242	15.0	91.1	20.9	30.5	42.5	35.5	19.5	0.168
Total	495	15.0	100.9	20.2	28.1	40.4	34.3	18.8	
Weight									
Male	253	35.7	108.0	66.4	73.8	82.2	74.4	11.7	
Female	242	42.1	96.3	58.2	64.0	70.6	64.8	10.0	0.020
Total	495	35.7	108.0	61.5	68.4	76.9	69.7	11.9	
Height									
Male	253	141.4	182.5	163.5	166.8	170.0	166.8	5.6	
Female	242	142.8	165.2	151.7	154.4	157.0	154.6	4.2	0.002
Total	495	141.4	182.5	154.4	160.4	167.0	160.8	7.9	
BMI									
Male	253	17.1	38.5	23.9	26.1	29.8	26.7	3.7	
Female	242	18.3	39.9	24.3	26.6	29.2	27.1	3.8	0.568
Total	495	17.1	39.9	24.1	26.4	29.5	26.9	3.8	
Total family income									
Male	253	0.0	5190.0	706.0	1130.0	1340.0	1120.0	778.9	
Female	242	0.0	5190.0	716.0	1138.0	1425.0	1208.2	841.5	0.501
Total	495	0.0	5190.0	716.0	1130.0	1400.0	1163.1	810.5	
Household per capita income									
Male	253	0.0	550.0	46.6	75.0	108.0	89.8	72.4	
Female	242	0.0	550.0	48.3	75.0	104.0	91.3	71.6	0.765
Total	495	0.0	550.0	47.8	75.0	104.0	90.5	71.9	
Owned household goods									
Male	253	-1.1	4.4	-0.8	-0.3	0.6	0.0	1.0	
Female	242	-1.1	4.4	-0.7	-0.2	0.5	0.0	1.0	0.997
Total	495	-1.1	4.4	-0.7	-0.2	0.5	0.0	1.0	
Agriculture/livestock farming									
Male	253	-3.0	2.2	-0.7	-0.1	0.7	0.0	1.0	
Female	242	-3.0	2.2	-0.7	-0.1	0.7	0.0	1.0	0.737
Total	495	-3.0	2.2	-0.7	-0.1	0.7	0.0	1.0	
Hunting/gathering									
Male	253	-2.7	3.4	-0.5	0.1	0.6	0.0	1.0	
Female	242	-2.7	3.4	-0.9	0.0	0.4	-0.1	1.0	0.968
Total	495	-2.7	3.4	-0.5	0.1	0.6	0.0	1.0	
Purchasing									
Male	253	-4.5	1.6	-0.3	0.1	0.7	0.0	1.0	
Female	242	-4.5	1.6	-0.3	0.1	0.7	0.0	1.0	0.703
Total	495	-4.5	1.6	-0.3	0.1	0.7	0.0	1.0	

Note: * Student t test; Min: minimum; Max: maximum; P25: 25th percentile; P75: 75th percentile; BMI: weight(kg)/height(cm)2.

Source: Authors.

The averages of height and weight obtained in this study are comparable to those verified in the previous survey conducted with the Xavante from the Pimentel Barbosa and Etênhiritipá villages in 2006. The same happened in relation to the values of Body Mass Index (BMI), given that the averages for men and women corresponded to 27.8 Kg/m² and 27.9 Kg/m², respectively in 2006[10]. In that study, Welch and collaborators conducted a temporal analysis of the nutritional state of the Xavante, revealing an average weight gain when comparing the findings of studies con-

Table 2. Distribution, overall and by sex, of individuals according to groups of villages, sociodemographics, and economic variables for Xavante individuals, aged 15 years or over. Central Brazil, 2011.

	Male		Female		Total	
	n	%	n	%	n	%
Groups of villages						
1st group	140	55.3	140	57.9	280	56.6
2nd group	74	29.2	67	27.7	141	28.5
3rd group	39	15.4	35	14.5	74	14.9
Total	253	100.0	242	100.0	495	100.0
Age group						
< 20 years of age	61	24.1	52	21.5	113	22.8
20 to 49 years of age	157	62.1	146	60.3	303	61.2
50 years of age and over	35	13.8	44	18.2	79	16.0
Education						
Unschooled	40	16.8	84	39.3	124	27.4
1 to 4 years	37	15.5	77	36.0	114	25.2
5 a 8 years	119	50.0	51	23.8	170	37.6
High School or Haiyo	42	17.6	2	0.9	44	9.7
Household per capita income						
0 to 54.99	80	31.6	71	29.3	151	30.5
55.00 to 109.99	110	43.5	117	48.3	227	45.9
110.00 to 550.00	63	24.9	54	22.3	117	23.6
Household goods						
Low	87	35.1	82	34.5	169	34.8
Medium	79	31.9	80	33.6	159	32.7
High	82	33.1	76	31.9	158	32.5
Hunting/gathering						
Low	76	31.3	83	35.5	159	33.3
Medium	85	35.0	81	34.6	166	34.8
High	82	33.7	70	29.9	152	31.9
Agriculture/livestock farming						
Low	82	33.1	79	33.2	161	33.1
Medium	84	33.9	80	33.6	164	33.7
High	82	33.1	79	33.2	161	33.1
Purchasing						
Low	84	34.6	75	32.1	159	33.3
Medium	74	30.5	76	32.5	150	31.4
High	85	35.0	83	35.5	168	35.2
Number of residents per household						
0 to 9 residents	53	20.9	42	17.4	95	19.2
10 to 19 residents	161	63.6	152	62.8	313	63.2
20 to 29 residents	39	15.4	48	19.8	87	17.6

Groups of villages: 1st group (Villages Pimentel Barbosa and Etênhiritipá); 2nd group (Villages Caçula. Canoa and Wedezé); 3rd group (Villages Tanguro. Asereré and Reata).

Source: Authors.

ducted in the 1960s by Neel[28] and Niswander[31], with later studies. The anthropometric surveys conducted with the Xavante from São Domingos and Simões Lopes, in the 1960's, showed weight averages of 67.2 Kg for men and 54.0 Kg for women in São Domingos, and 69.8 Kg for men and 57.9 kg for women in Simões Lopes. The height averages were 168.1cm and 170.2cm for men and 154.7 cm and 156.3 cm for women, respectively, in the same villages.

An increase was noticeable in weight averages among the Xavante, when we compare the

Table 3. Prevalence of excess weight and obesity among Xavante adults according to the frequency of sociodemographic and economic variables for Xavante individuals, aged 15 years and over. Central Brazil. 2011.

	Excess weight			Obesity		
	n	**%**	**p-value**	**N**	**%**	**p-value***
Sex						
Male	160	63.2	0.209	54	21.3	0.377
Female	166	68.6		44	18.2	
Total	326	65.9		98	19.8	
Groups of villages						
1st group	196	70.0	0.080	58	20.7	0.068
2nd group	84	59.6		20	14.2	
3rd group	46	62.2		20	27.0	
Age group						
< 20 years of age	46	40.7	0.000	4	3.5	0.000
20 to 49 years of age	234	77.2		87	28.7	
50 years of age and over	46	58.2		7	8.9	
Education						
Unschooled	81	65.3	0.700	21	16.9	0.015
1 to 4 years	83	72.8		31	27.2	
5 to 8 years	100	58.8		26	15.3	
High School or Haiyo	32	72.7		14	31.8	
Household per capita income						
0 to 54.99	93	61.6	0.408	27	17.9	0.737
55.00 to 109.99	153	67.4		48	21.1	
110.00 to 550.00	80	68.4		23	19.7	
Owned household goods						
Low	108	63.9	0.181	23	13.6	0.027
Medium	114	71.7		40	25.2	
High	99	62.7		34	21.5	
Hunting/gathering						
Low	119	74.8	0.005	45	28.3	0.008
Medium	96	57.8		25	15.1	
High	101	66.4		27	17.8	
Agriculture/livestock farming						
Low	116	72.0	0.003	34	21.1	0.318
Medium	114	69.5		37	22.6	
High	89	55.3		26	16.1	
Purchasing						
Low	104	65.4	0.891	33	20.8	0.388
Medium	101	67.3		34	22.7	
High	109	64.9		28	16.7	
Number of residents per household						
0 to 9 residents	69	72.6	0.138	19	20.0	0.288
10 to 19 residents	206	65.8		67	21.4	
20 to 29 residents	51	58.6		12	13.8	

Groups of villages: 1st group (Villages Pimentel Barbosa and Etênhiritipá); 2nd group (Villages Caçula, Canoa and Wedezé); 3rd group (Villages Tangurom Asereré and Reata). * Chi-squared test.

Source: Authors.

results of surveys conducted in 1977[32] and in the 1990s[27]. In that study, the authors documented an increase in weight averages of 4.4 kg for men and 1.3 kg for women. Besides the high averages of BMI, our study also revealed a high prevalence of overweight and obesity, of 46.1% and 19.8%,

Table 4. Regression models for overweight and obesity among Xavante individuals, aged 15 years and over. Mato Grosso, 2011.

Final model: excess weight					
	n	**(%)**	**OR**	**IC95**	**p-value**
Sex					
Male	160	63.2	1	-	-
Female	166	68.6	1.63	1.04-2.58	0.035
Groups of villages					
1st group	196	70.0	1	-	-
2nd group	84	59.6	0.58	0.35-0.96	0.034
3rd group	46	62.2	0.57	0.31-1.06	0.077
Age groups					
< 20 years of age	46	40.7	1	-	-
20 to 49 years of age	234	77.2	4.90	2.92-8.25	0.000
50 years of age and over	46	58.2	2.75	1.19-6.32	0.018
Education					
Unschooled	81	65.3	1	-	-
1 to 4 years	83	72.8	2.63	1.38-5.00	0.003
5 to 8 years	100	58.8	1.70	0.89-3.23	0.106
High School or Haiyo	32	72.7	3.15	1.28-7.73	0.012
Agriculture/livestock farming					
Low	0	0.0	1	-	-
Medium	230	70.8	0.90	0.54-1.50	0.689
High	89	55.3	0.43	0.30-0.81	0.005
Final Model: obesity					
	n	**(%)**	**OR**	**IC95**	**p-value**
Age groups					
< 20 years of age	4	3.5	1	-	-
20 to 49 years of age	87	28.7	11.09	3.95-31.13	0.000
50 years of age and over	7	8.9	2.91	0.83-10.53	0.096
Hunting/gathering					
Low	45	28.3	1		
Medium	25	15.1	0.48	0.27-0.84	0.011
High	27	17.8	0.62	0.35-1.09	0.950

Grupos de aldeias: 1º grupo (aldeias Pimentel Barbosa e Etênhiritipá); 2º grupo (aldeias Caçula, Canoa e Wedezé); 3º grupo (aldeias Tanguro, Asereré e Reata).

Fonte: Autores.

respectively, which were 50.4% and 18.2% for women and 41.9% and 21.3% for men, respectively. This shows that only 34.1% of the Xavante population (36.8% of men and 31.4% of women), aged 15 years and older, residing in the studied IL, had a BMI within the standards of normality recommended by the WHO[33]. In the general Brazilian population, in 2008-2009, the prevalence of excess weight reached 50.1% and 48.0% of adult men and women, respectively[34].

When the results of this study are compared with the findings of the 1st National Health and Nutrition Survey of Indigenous Peoples (NHNSIP), conducted between 2008-2009, and based on a representative sample of Indigenous females residing in villages in the entire national territory, 14 to 49 years of age[19], we noticed that the values found for Xavante women surpass the proportions observed in a national scale for excess weight and obesity, reaching 46.2% and 15.8%, respectively. The same conclusion applies to the comparison of the prevalence reported for Indigenous women from the Midwest region, where the population of the current study lives (52.8% and 17.2%)[7]. When we use the same age group from the national survey in the verification of prevalence, the levels of excess weight and obesity among Xavante women were even more

pronounced, reaching 69.9% and 20.4%, respectively.

Sadly, this kind of result has been seen increasingly more often in the Brazilian Indigenous context. A high prevalence of overweight and obesity are recurring findings in studies conducted throughout the country. In many of those investigations, this kind of prevalence surpasses the 60% mark, as in the case of studies conducted with the Parkatêjê people, which verified excess weight prevalence of 62.5% among women[35] and 67.8% and 14.4% of excess weight and obesity for both sexes, respectively[36]. In the Amazon region, a study conducted by Lourenço and collaborators[9] also revealed a significant prevalence, of 42.3% for overweight and 18.2% for obesity for both sexes. In addition to these studies, others, which focused on specific Indigenous populations from different regions, also found a high prevalence of overweight and obesity[13,15,27,37-39].

When we compare the results of our study with those of other surveys conducted with the Xavante people, some differences are relevant. When we contrast the prevalence of excess weight and obesity in our study, with what was found by the study of the Xavante from Pimentel Barbosa/Etênhiritipá (66.7% and 20.8% for men and 55.6% and 17.3% for women, respectively), we can notice similarities, except for a smaller difference in the prevalence of excess weight among women, found by the work of Welch *et al.*[10] Likewise the results found for obesity among the Xavante people from the villages of Sangradouro-Volta Grande and Pimentel Barbosa (24.6% of the men and 41.3% of the women) showed lower prevalences in the present study[27].

Given this scenario, we consider the continuous investigation on the health of specific Indigenous communities, with the analysis of their anthropometric profile in different moments, as something fundamental for the verification of secular tendencies of prevalence of nutritional deficiencies. Moreover, such an approach enables the observation of associations between nutritional state and the socioeconomic changes that those communities have endured, with the monetization of Indigenous economy and a decrease in the frequency of physical activities[8,9,27,40].

In the context of the Xavante, the expansion of the demographic and economic frontiers have, historically, impacted their territories, resulting in a loss of lands, environmental degradation, and an introduction of new economic relationships[8,28]. Traditional economy, based on subsistence farming, hunting, fishing, and gathering, has been substituted for outside economic relationships, compromising their autonomy and food source sustainability and leading to a dependence on industrialized foods[8].

Such foods, which are rich in carbohydrates and fats, have contributed for an increase in caloric intake, and the lack of physical activity resulting from factors like the decline in traditional practices that demanded physical effort and considering the mechanization of agriculture, leading to a sedentary way of life (with more time in front of the TV and doing other leisure activities), which resulted in less energy being spending[10,41,42]. This shows how historical and socioeconomic determinants have influenced patterns of eating and of physical activity, thus contributing to an increasing prevalence of excess weight and obesity, as well as for other health illnesses, such as diabetes and hypertension[17].

When we examine the prevalence of excess weight and obesity in relation to the patterns of food consumption, we can notice that the highest prevalence occurred in the low levels of the frequency of the consumption of foods from hunting, fishing, and gathering, as well as from agriculture and livestock farming. For this last category, the difference observed proved only to be statistically significant for the excess weight outcome ($p < 0.05$). This pattern suggests that the Indigenous individuals residing in households with less practice of traditional means of subsistence had higher frequencies of excess weight and obesity, a result analogous to what is found for Indigenous populations throughout the country[7].

A relationship comparable to the National Survey can be seen as well in terms of the socioeconomic indicator "owned household goods". In this context, a higher prevalence of obesity was observed in the medium and high strata. These results are in agreement with those of the NHNSIP, in which the index of owned household goods and the presence of regular family income showed positive associations with excess weight and obesity in multivariate analyses[7]. Furthermore, this association reflects similarities with what was found for the Saruí people, for whom the higher socioeconomic stratum had the highest obesity prevalence[9].

When adjusted in multivariate analyses, the variables of sex, village group, age group, education, and pattern of the acquisition of food by agriculture and livestock farming demonstrated significant associations with the excess weight outcome. By contrast, in the model associated

with obesity, only the variables of age group and pattern of the acquisition of food by hunting, fishing, or gathering remained in the final model. The associations found in our study converge with those found for other Indigenous populations in Brazil[15,39]. For example, a study conducted with the Xukuru people from Ororubá found that the highest prevalence of excess weight and obesity was associated with the female sex and the older age groups[15].

The positive association between age and excess weight is a finding that is recurrent in scientific literature, and it is often more pronounced among women. The relationship between older age and predisposition to excess weight may be attributed to changes in basal metabolic rate and to modifications in lifestyle, including the reduction of traditionally practiced physical activities. We can infer that the association between being excess weight and being female may reflect cultural and gender dynamics which influence the patterns of eating and of physical activities. It is plausible to consider that sociocultural factors, such as traditional gender roles, are contributing to the observed pattern. Moreover, aspects related to household tasks and family care may affect the availability of time for regular physical activities.

The association found between the reduction of frequency of traditional practices of food acquisition, such as agriculture, livestock farming, and hunting, fishing, and gathering activities, and the presence of excess weight and obesity, indicates the possibility that these populations are acquiring eating patterns based on the regional market and the consumption of industrialized foods. Reduction of physical activity was also related with more dependence on industrialized foods among the Xavante[8,10]. Such findings indicate a potential change in the subsistence conditions and eating patterns in those villages[10,15,18].

Considering education level, a positive association tendency was verified with the occurrence of excess weight. However, this finding contradicts results found in studies considering the general population of Brazil, which indicate an inverse relationship between education and excess weight and obesity outcomes[43]. The results found for the Xavante also diverge from those of the National Survey of Indigenous Health, in which education was identified as a protection factor against overweight and obesity[7].

The growing prevalence of excess weight and obesity among the Xavante is a warning of the sociocultural, economic, and environmental changes taking place in the Xavante villages and their repercussions on health and food security of these populations. Protection of Indigenous land is essential for guaranteeing access to traditional, healthy foods. Food security is essential, requiring policies that can promote the autonomy of Indigenous people in terms of managing their natural resources and preserving sustainable eating habits. These findings highlight the need for the implementation of healthcare policies that consider the specific needs of Indigenous populations, respecting their traditions and worldviews.

Collaborations

FG Tavares and AM Cardoso developed the concept and design of the study. JRM Lucena was involved in data collection. FG Tavares and AM Cardoso conducted the statistical analyses. FG Tavares and AM Cardoso wrote the draft. The final version to be submitted for publication was read and approved by all of the authors.

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