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Prevalence of major cardiometabolic diseases in the riverine populations from the interior of the State of Amazonas, Brazil

Paulo Lima de Azevedo and Silvia Regina Sampaio Freitas*

*Departamento de Ciências Biológicas, Centro de Estudos Superiores de Tefé, Universidade do Estado do Amazonas, Estrada do Bexiga, 1085, 69470-000, Juruá, Tefé, Amazonas, Brazil. *Author for correspondence. E-mail: silvia.sampaio.freitas@hotmail.com*

ABSTRACT. This study aimed to estimate the prevalence of major cardiometabolic diseases according to the sociodemographic characteristics and lifestyle in the riverine communities of the municipalities of Tefé and Santa Isabel do Rio Negro, State of Amazonas, Brazil. Descriptive tests and logistic regression models were used to estimate the effect of age, gender, marital status, education, smoking, alcohol consumption and sedentary lifestyle on the prevalence of cardiometabolic diseases in 552 adults aged from 18 to 78 years. The prevalence of hypertension, diabetes and obesity in Tefé and Santa Isabel do Rio Negro were respectively 28 / 30.7%; 28.2/ 8.9%; and 22.3 / 42%. In Tefé, married men, aged over 35 years, were more susceptible to the cardiometabolic diseases. In Santa Isabel do Rio Negro, smoking men aged over 35 with low education level were more prone to diabetes and hypertension. Such data reinforce the need to monitor the risk indicators as a preventive measure and early detection of some cardiometabolic diseases.

Keywords: obesity, arterial hypertension, *diabetes mellitus*.

Prevalência das principais doenças cardiometabólicas em populações ribeirinhas do interior do Amazonas, Brasil

RESUMO. O objetivo deste trabalho foi estimar a prevalência das principais doenças cardiometabólicas segundo características sociodemográficas e estilo de vida nos ribeirinhos Amazônicos residentes nos municípios de Tefé e de Santa Isabel do Rio Negro. Testes descritivos e de regressão logística foram aplicados para estimar o efeito da idade, gênero, estado civil, escolaridade, tabagismo, etilismo e sedentarismo na prevalência das doenças cardiometabólicas em 552 adultos, com idade variando de 18 a 78 anos. Os resultados da análise descritiva indicaram que as prevalências da hipertensão, *diabetes* e obesidade nos ribeirinhos de Tefé e Santa Isabel do Rio Negro foram respectivamente: 28 / 30,7%; 28,2 / 8,9; e 22,3 / 42%. Em Tefé, a frequência das doenças cardiometabólicas foi maior entre homens, casados e com idade superior a 35 anos; enquanto que em Santa Isabel do Rio Negro, observou-se o aumento da prevalência da hipertensão e do *diabetes* nos indivíduos com perfil masculino, tabagistas, com idade acima de 35 anos e com baixa escolaridade. Esses dados reforçam a necessidade da vigilância dos indicadores de risco como medida de prevenção e detecção precoce de algumas doenças cardiometabólicas.

Palavras-chave: obesidade, hipertensão arterial, *Diabetes mellitus*.

Introduction

Cardiometabolic diseases - *diabetes mellitus*, obesity and cardiovascular diseases - are one of the most serious public health problems today (Passi, 2016). This is due to the large number of people affected, as well as the associated comorbidities, leading to premature incapacitations and deaths (Tavares et al., 2015). The prevalence of these chronic health problems has increased considerably and reached epidemic proportions worldwide (Passi, 2016).

In 2012, cardiometabolic diseases were the leading causes of death in the world, accounting for 68% of deaths (Sommer et al., 2015). Approximately 75% deaths due to complications of *diabetes mellitus*, obesity and cardiovascular diseases occurred in low- and middle-income countries, and 40% were considered premature deaths (before 70 years of age) (Sommer et al., 2015). As reported in other countries, data from the Ministry of Health indicated that cardiometabolic diseases accounted for 70% of deaths in Brazil in recent years (Schmidt et al., 2011).

In the last decades, the prevalence of cardiometabolic diseases has been increasing due to the decrease in physical activity, changes in eating habits and increase in the average life of the population observed mainly in the populations of large urban centers (Balakumar, Maung-U, & Jagadeesh, 2016). Observation of factors such as sedentary lifestyle, smoking and alcohol

consumption has been one of the most effective ways to establish primary prevention and early detection of cardiovascular diseases, among other cardiometabolic conditions (Singhal, 2014). However, the adoption of such measures still poses a challenge for health managers, especially in isolated areas such as quilombola (Melo & Silva, 2015), indigenous (Pereira, Biruel, Souza Oliveira, & Rodrigues, 2014) and riverine (Oliveira et al., 2013) populations.

In the State of Amazonas, riverine populations are characterized by subsistence activities (dos Santos Tavares, da Silva, Dal Sasso, Padilha, & Santos, 2014) and have been changing their habits due to infrastructure projects (Oliveira et al., 2013); migratory processes (dos Santos Gonçalves, Benchimol-Barbosa, de Souza Hacon, & de Castro, 2016), and changes in dietary habits (Mertens et al., 2015). In relation to the communities located in the Medium Solimões, stand out the construction works of the Urucu-Coari-Manaus gas pipeline, located near the cities of Tefé and Coari. The socio-environmental impacts of these undertakings on lifestyle may be important enough to alter the quality of life and the morbidity and mortality profile of the riverine populations of these cities (Oliveira et al., 2013; dos Santos Tavares, da Silva, Dal Sasso, Padilha, & Santos, 2014; dos Santos-Gonçalves et al., 2016). A concern would be the possibility of increasing the prevalence of cardiometabolic diseases in the population living in areas of direct and/or indirect influence of these enterprises (Oliveira et al., 2013). On the other hand, the migratory flow promoted by the proximity of the municipalities of the interior of the State, as is the case of the city of Santa Isabel do Rio Negro, with other countries can also influence the prevalence and incidence of cardiometabolic diseases. IBGE data indicate that 23% of the population living in the urban area of Santa Isabel do Rio Negro is considered a transient population (IBGE, 2010a). This characteristic is due to the high number of individuals from Venezuela and Brazilian Army soldiers who emigrate to Santa Isabel do Rio Negro for a short period of time (Instituto Brasileiro de Geografia e Estatística [IBGE], 2010a; Exército Brasileiro, 2014).

Investigations on the health status of riverine populations and its main determinants will allow comparisons with future assessments and the possible detection of health system fragilities, in addition to increasing the understanding of the magnitude and historical trends of morbidity and mortality risks in these population groups (Oliveira et al., 2013). In this context, the present study aimed to estimate the prevalence of major cardiometabolic diseases (obesity, *diabetes mellitus* [DM], arterial hypertension [AH]) and to describe them according to sociodemographic and lifestyle descriptors in the riverine populations living in the municipalities of Tefé and Santa Isabel do Rio Negro, State of Amazonas.

Material and methods

The research was approved by the Research Ethics Committee of the State University of Amazonas, through the opinion 407080, of September 26, 2013. The interviewees signed the Informed Consent to participate in the research, whose ethical precepts were assured with the fulfillment of Resolution of the National Health Council 466, of December 12, 2012.

This is an observational, descriptive, cross-sectional, population-based study conducted between 2014 and 2016. The methodological approach involved the use of structured questionnaires for the riparian populations of the municipalities of Tefé and Santa Isabel do Rio Negro (Figure 1). These municipalities are located in the interior of the State of Amazonas, and have in common the fact that their populations live on the banks of the main rivers of the Amazon region, the Solimões River and the Negro River, respectively.

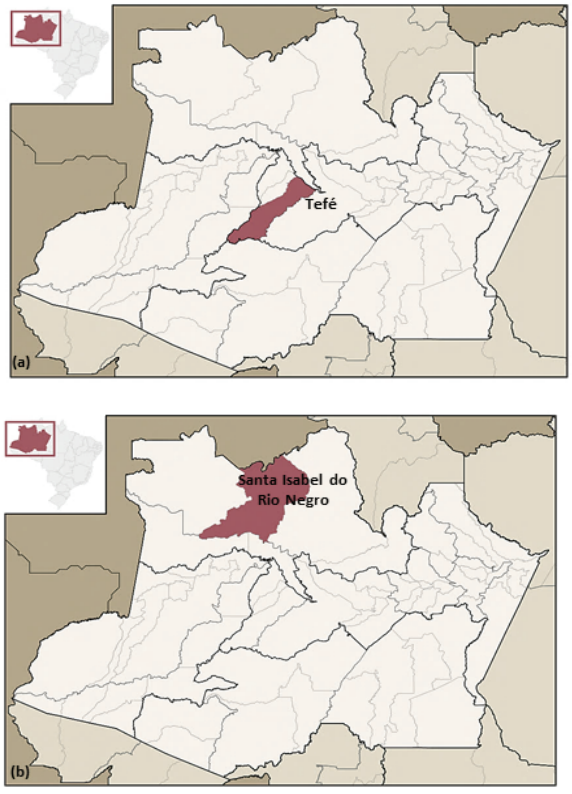

Figure 1. Political-administrative map of the State of Amazonas. (a) municipality of Tefé. (b) municipality of Santa Isabel do Rio Negro (adapted from Google Images).

The municipality of Tefé is in the region of the Medium Solimões and occupies a territorial area of 23,704 km². The 2010 Census estimated the population of Tefé at 61,453 inhabitants, 31,492 males and 29,907 females (Instituto Brasileiro de Geografia e Estatística. [IBGE], 2010b). Approximately 81.5% of the population lives in the urban area of the municipality and 18.5% in the rural area (IBGE, 2010b). The calculation of the sample used the information of the Demographic Census referring to the population of the urban area reported by the Brazilian Institute of Geography and Statistics in the year 2010, making a total of 61,453 adults, having established the number of 380 individuals to be studied. The statistical software Epi-Info 3.5.1 was used to calculate the sample, with a 95% confidence interval, 50% ratio and 5% estimation error. With a 20% increase for possible losses or refusals, the total sample size was 451 adults.

Santa Isabel do Rio Negro is located in the northeastern State of Amazonas, in the Upper Negro River region (IBGE, 2010a). The municipality occupies an area of 62,846 Km^2, of which 90% covered by the Amazon Forest (IBGE, 2010a). The population of Santa Isabel do Rio Negro has 10,561 inhabitants, 4,220 live in the city and 6,341 are distributed in indigenous communities (IBGE, 2010a). The same statistical parameters were used to calculate the sample size. One hundred and one representatives from Santa Isabel do Rio Negro, aged 18 years or older, participated voluntarily in this study.

Sample selection had as reference unit the census sectors, according to the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE), totaling 18 sectors in Tefé (IBGE, 2010b) and 1 in Santa Isabel do Rio Negro (IBGE, 2010a). From each sector, a simple random sample proportional to the number of individuals living in each of these sectors was selected, considering the sample size. Due to the proportion considered and for better distribution for neighborhood purposes, a domicile was raffled off and five were skipped. In case the domicile is empty, the house immediately next was chosen. Pregnant women, mothers of children under six months of age, indigenous people and their descendants, children under 18 years of age and those with physical and/or mental limitations that could hinder data collection were not included in the study.

The epidemiological investigation of sociodemographic, lifestyle and health descriptors occurred through a questionnaire elaborated by the researchers specifically for this study. A multidisciplinary team consisting of a nursing technician and a biologist (scorer) was responsible for conducting the interviews and applying the questionnaires and evaluating the health descriptors. The interviews, previously scheduled with one of the heads of household and according to the availability and convenience of the interviewee, had an average duration of 35 minutes and occurred at the participant's home. At the time of the interview, the biologist read the questions and wrote down the answers in a data sheet recorded in the mobile device exclusive to this study (WorkTab Q10 tablet; Philco). Afterwards, the nursing technician evaluated the health descriptors. The interviewee remained seated during blood pressure measurement, glucose measurement and standing for weight and height checks. During this stage, the biologist remained beside the evaluator to record the results in the data sheet.

The socio-demographic variables studied included gender, age, marital status (single, married or stable cohabiting, separated or divorced) and level of education (illiterate, complete/incomplete elementary education, complete/incomplete high school, complete/incomplete higher education).

Regarding lifestyle, we investigated: smoking, categorized in nonsmokers and active smokers (≥ 1 pack per week); the consumption of alcoholic beverages in relation to the 30 days prior to the interview (yes or no); and sedentarism measured by physical activity frequency (sedentary: individuals who reported not doing physical activity, or who performed physical activity less than three times a week; active: individuals who reported performing physical activities regularly or three or more times a week).

Information on cardiometabolic diseases - arterial hypertension, *diabetes mellitus* and obesity - were obtained through blood pressure measurement, fasting glucose determination and body mass index (BMI) assessment, respectively. Blood pressure was measured in triplicate and with a semiautomatic device (HEM 711AC, OMRON), considering the average of the three measurements (James et al., 2014). The measurements were made with the individual sitting, after five minutes of rest and after having stayed at least 30 minutes without drinking coffee or smoking (James et al., 2014). In each individual, systolic (SBP) and diastolic (DBP) values were calculated from the arithmetic mean of the three measurements. The individual was classified as hypertensive if reported using an antihypertensive medication, even if irregular, or presented mean values of SBP≥140mmHg and/or DBP≥90mmHg (James et al., 2014). The diagnosis of diabetes was based on the history, use of hypoglycemic drugs and a capillary glycemia level

above 126mg dL^{-1} (Sociedade Brasileira de Diabetes, 2016). Plasma levels were measured using a commercial kit (Accu-Chek Active, ROCHE) at the interviewee's residence. The interviewees were previously instructed to be fasting for 8 hours on the day of capillary glucose measurement. The BMI of each individual was calculated by dividing the weight (body mass in kilograms) by the square of the height (in meters), with data of weight and height measurements obtained. The characterization of the nutritional status of the participants was based on the cutoff points for BMI, as recommended by the Sociedade Brasileira de Endocrinologia e Metabologia (2010). The BMI classified individuals as normal ($<30kg\ m^{-2}$) and obese ($\geq 30kg\ m^{-2}$). The interviewers assessed the weight of the interviewee with the help of a portable scale (BF572 Body Fat, Tanita Corp., capacity of 130kg with intervals of 100g), and measurement of height by portable stadiometer graduated in millimeters.

Statistical analyses were run in SPSS software 20.0 and included: 1) descriptive analysis, showing the absolute, relative frequencies and mean values and standard deviation; 2) comparative analysis of sociodemographic, lifestyle and health parameters to determine differences and similarities between the populations of Tefé and Santa Isabel do Rio Negro, using Student's t-tests for continuous variables, and the chi-square test for qualitative variables; and 3) multiple logistic regression analysis to estimate the effect of sociodemographic and lifestyle descriptors on the prevalence of cardiometabolic diseases (AH, obesity and DM). The results are presented in Odds Ratio (OR) and with a 95% confidence interval (95% CI). The level of significance for all tests was set at $\alpha = 0.05$.

Results and discussion

The results of the descriptive analyses carried out on sample data collected in Tefé and Santa Isabel do Rio Negro are summarized in Table 1.

The population sample of Tefé was composed of 41.7% men, mean age of 38.67 ± 14.42 years; and 58.3% women, with mean age of 38.20 ± 14.42 years. There was no significant difference in the means of the ages between the genders ($p = 0.40$). 47% of the participants are single, while 39% are married. The proportion of divorced or separated reached 14% of the sample. Most of the interviewees (42.9%) reported that they were attending college or have higher education. However, 27% of respondents reported only elementary education, while 5.2% reported being illiterate. As for lifestyle, only 6.4% declared to be smoker. However, 34.8% reported having a habit of consuming alcoholic beverages and 60.1% did not practice physical activities. Regarding the health variables, it was verified that the frequencies of cardiometabolic diseases among the riverine population of Tefé were: 28% for arterial hypertension, 28.2% for *diabetes mellitus* and 22.3% for obesity.

In Santa Isabel do Rio Negro, among the 101 individuals interviewed, 43.6% were men and 56.4% were women. The mean age of the men was 37.93 ± 14.12 years, while the women had a mean age of 40.51 ± 15.83 years. There was no statistically significant difference between the mean values of age between genders ($p = 0.40$). The study sample consisted of 43.6% singles, 34.6% married, and 21.8% of divorced or separated. Regarding the educational profile, the majority of respondents had completed high school education or is attending (52.5%), 31.7% had completed elementary education or is attending, and a minority (4.9%) claimed to be illiterate. Only 11% reported having a college degree. The evaluation of the lifestyle descriptors showed that the residents of Santa Isabel do Rio Negro are mostly sedentary (74.2%). The prevalence of other lifestyle indicators was below 50%. Frequent consumption of alcoholic beverages was admitted by 35.6% of the interviewees, while 31.7% reported having a smoking habit. Finally, the analysis of health descriptors showed that obesity and arterial hypertension are the most frequent chronic diseases among those interviewed. The prevalence of hypertension and obesity reached 30.7 and 42%, respectively. *Diabetes mellitus*, the type of cardiometabolic disease less frequent among the riverine population of Santa Isabel do Rio Negro, was present in 8.9% of the interviewees.

The results of the logistic regression analyses of cardiometabolic diseases according to sociodemographic descriptors are summarized in Table 2.

The results of the logistic regression analysis for the Tefé riverine population indicated aging as an important sociodemographic factor associated with the cardiometabolic diseases investigated in this study. From the age of 35, the probability of occurrence of diabetes was approximately 2.5 times higher when compared to younger subjects ($p \leq 0.001$). The occurrence of obesity and hypertension also increased with advancing age. In these cases, the probability of obesity was 1.6 times higher ($p = 0.04$); whereas for arterial hypertension, the probability was 2.98 ($p \leq 0.001$) from the age of 35 years. Regarding gender, it was observed that men presented a 2.2-fold higher probability of an increase in blood pressure when compared with women ($p \leq 0.001$). Marital status was also associated with cardiometabolic diseases. In Tefé, married people showed a correlation 1.8 times higher for obesity ($p = 0.01$) and arterial hypertension ($p = 0.05$). The education level was the only sociodemographic descriptor that did not correlate with DM.

Table 1. Sociodemographic, lifestyle and health profile of riverine populations of Tefé and Santa Isabel do Rio Negro, in the interior of the State of Amazonas, 2014-2016.

Descriptors	Tefé (n = 451)	Santa Isabel do Rio Negro (n= 101)	Total (n = 552)	P-value
Sociodemographic				
Age	38.40±14.40	39.39±15.09	38.58±14.52	0.54
Gender				
Male	188 (41.70%)	44 (43.60%)	232 (42.00%)	0.73
Female	263 (58.30%)	57 (56.40%)	320 (58.00%)	
Marital status				
Single	211 (47.00%)	44 (43.60%)	255 (46.40%)	
Married	175 (39.00%)	35 (34.60%)	210 (38.20%)	0.15
Others	63 (14.00%)	22 (21.80%)	465 (15.40%)	
Education				
Illiterate	23 (5.20%)	05 (4.90%)	28 (5.20%)	
Elementaryeducation	119 (27.00%)	32 (31.70%)	151 (27.90%)	≤0.001
High school	110 (24.90%)	53 (52.50%)	163 (30.10%)	
Highereducation	189 (42.90%)	11 (10.90%)	200 (36.90%)	
Lifestyle				
Sedentarylifestyle	268 (60.10%)	75 (74.20%)	343 (62.10%)	≤0.001
Smoker	29 (6.40%)	32 (31.70%)	61 (11.10%)	≤0.001
Alcoholconsumption	157 (34.80%)	36 (35.60%)	193 (35.00%)	0.87
Health				
ArterialHypertension	126 (28.00%)	31 (30.70%)	295 (53.40%)	0.82
Diabetes mellitus	126 (28.20%)	09 (8.90%)	135 (24.60%)	≤0.001
Obesity	100 (22.30%)	42 (42.00%)	142 (25.90%)	≤0.001

Table 2. Logistic regression analysis of sociodemographic descriptors of risk for cardiometabolic diseases in the riverine populations of Tefé and Santa Isabel do Rio Negro.

	TEFÉ			SANTA ISABEL DO RIO NEGRO		
	Hypertension	*Diabetes mellitus*	Obesity	Hypertension	*Diabetes mellitus*	Obesity
Age[1]						
Over 35 years	OR = 2.98★ ($CI_{95\%}$:2.00-4.44)	OR = 2.46★ ($CI_{95\%}$:1.59-3.79)	OR = 1.61★ ($CI_{95\%}$:1.02-2.54)	OR = 3.39★ ($CI_{95\%}$:1.39-8.68)	OR = 2.12 ($CI_{95\%}$:0.48-9.33)	OR = 1.71 ($CI_{95\%}$:0.77-3.83)
Gender[2]						
Male	OR = 2.21★ ($CI_{95\%}$:1.46-3.32)	OR = 1.34 ($CI_{95\%}$:0.87-2.05)	OR = 1.43 ($CI_{95\%}$:0.91-2.24)	OR = 2.64★ ($CI_{95\%}$:1.07-6.53)	OR = 5.46★ ($CI_{95\%}$:1.06-8.03)	OR = 1.32 ($CI_{95\%}$:0.59-2.96)
Marital status[3]						
Married	OR = 1.80★ ($CI_{95\%}$:1.18-2.75)	OR = 1.26 ($CI_{95\%}$:0.80-1.98)	OR = 1.84★ ($CI_{95\%}$:1.12-3.01)	OR = 1.92 ($CI_{95\%}$:0.33-3.76)	OR = 1.21 ($CI_{95\%}$:0.58-4.24)	OR = 0.90 ($CI_{95\%}$:0.47-2.23)
Others	OR = 1.47 ($CI_{95\%}$:0.81-2.67)	OR = 0.76 ($CI_{95\%}$:0.38-1.51)	OR = 0.89 ($CI_{95\%}$:0.41-1.93)	OR = 1.45 ($CI_{95\%}$:0.68-2.60)	OR = 0.81 ($CI_{95\%}$:0.48-3.44)	OR = 0.61 ($CI_{95\%}$:0.27-1.91)
Schooling[4]						
Illiterate	OR = 1.60 ($CI_{95\%}$:0.62-4.12)	OR = 1.44 ($CI_{95\%}$:0.54-3.82)	OR = 0.50 ($CI_{95\%}$:0.14-1.80)	OR = 2.64★ ($CI_{95\%}$:1.07-6.53)	OR = 5.46★ ($CI_{95\%}$:1.06-8.03)	OR = 1.32 ($CI_{95\%}$:0.59-2.96)
Elementary education	OR = 1.44 ($CI_{95\%}$:0.89-2.34)	OR = 1.59 ($CI_{95\%}$:0.95-2.65)	OR = 1.32 ($CI_{95\%}$:0.76-2.27)	OR = 1.64★ ($CI_{95\%}$:1.09-2.45)	OR = 1.63 ($CI_{95\%}$:0.74-3.58)	OR = 1.05 ($CI_{95\%}$:0.68-1.62)
High School	OR = 0.95 ($CI_{95\%}$:0.59-1.53)	OR = 1.20 ($CI_{95\%}$:0.70-2.05)	OR = 0.89 ($CI_{95\%}$:0.49-1.62)	OR = 0.96 ($CI_{95\%}$:0.64-1.45)	OR = 1.35 ($CI_{95\%}$:0.58-3.17)	OR = 0.97 ($CI_{95\%}$:0.62-1.52)

Legend: [1]Age used as reference: up to 35 years; [2]Gender of reference: female; [3]Marital Status of reference: single; [4]Reference education: Higher education; ★Value of $p < 0.05$.

In Santa Isabel do Rio Negro, the susceptibility profile to cardiometabolic diseases was slightly different from that observed in Tefé. For this population, aging was correlated only to increased blood pressure. Individuals older than 35 years had 3.93 more probability to develop hypertension compared to those younger than 35 years ($p = 0.01$). When assessing the relationship between gender and cardiometabolic diseases, it was observed that men are more likely to have *diabetes mellitus* and hypertension. *Diabetes mellitus* was 5.4 times more frequent in men ($p = 0.03$), while hypertension was 2.6 times ($p = 0.04$) when compared to women. The level of education contributed to the increased probability of *diabetes mellitus* and hypertension. *Diabetes mellitus* was five times more frequent in illiterate individuals ($p \leq 0.001$) when compared to those with higher education. Regarding the arterial hypertension, it was observed that the number of years of study was negatively correlated with AH. Among illiterate individuals, the prevalence of hypertension was 2.64 ($p \leq 0.001$), and decreased to 1.6 ($p = 0.02$) among subjects with elementary education. Although the result was not statistically significant, a downward and linear trend of correlation with the increase in blood pressure was found among the subjects with high school (OR = 0.96, $p = 0.84$). Marital status did not correlate with the development of *diabetes mellitus*.

The results of the logistic regression analyses of cardiometabolic diseases according to the lifestyle descriptors are illustrated in Figure 2.

The smokers living in Santa Isabel do Rio Negro had a 3.05-fold higher correlation of obesity ($p =$

0.03). Smoking was also correlated with *diabetes mellitus* (p = 0.03). In this case, the probability was 7.28 times (p = 0.03) when compared to those who are not smokers.

The other lifestyle descriptors showed no significant correlation for cardiometabolic diseases in Tefé or Santa Isabel do Rio Negro.

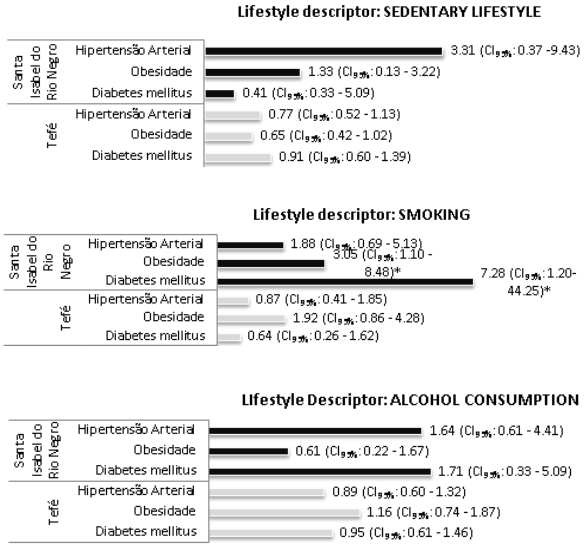

Figure 2. Results of the logistic regression analysis of cardiometabolic diseases according to the lifestyle descriptors, in the riverine populations of Santa Isabel do Rio Negro (dark bar) and Tefé (gray bar). * Value of $p < 0.05$.

Currently, the State of Amazonas has been highlighting in the national scenario due to the economic importance of the Manaus Free Trade Zone; and, more recently, the construction of the Urucu-Coari-Manaus gas pipeline. Such development and infrastructure projects in the Amazon region have raised discussions about socio-environmental impacts from increased migratory flow, increased commercialization of processed foods, demand for health services in public and private networks for populations located near these enterprises (Queiroz & Motta Veiga, 2012). National and international studies have shown that investments such as these can interfere with the economic, social and environmental dynamics of the region and modify the living standards of traditional populations, such as indigenous and riverine populations (Queiroz & Motta Veiga, 2012). Therefore, transformations resulting from large developmental works can directly interfere with the complex network of factors that condition the health of these population groups (Oliveira et al., 2013).

Epidemiological investigations performed in the State of Pará (Queiroz & Motta Veiga, 2012) and in Porto Velho, State of Roraima (Oliveira et al., 2013) showed changes in eating habits, quality of life, and the introduction of new health risk factors in population groups that live close to the sites of large hydroelectric projects. The incorporation of socioenvironmental risks may generate changes in the morbidity and mortality profile of, for example, cardiometabolic diseases (Queiroz & Motta Veiga, 2012).

In this sense, it can be expected that socio-environmental changes resulting from the construction of the Urucu-Coari-Manaus gas pipeline may, for example, influence the life habits of the riverine populations of the State of Amazonas and, consequently, increase the prevalence of cardiometabolic diseases. This study aimed to define the prevalence of hypertension, *diabetes mellitus* and obesity - major cardiometabolic diseases - according to their socioeconomic and lifestyle descriptors. The correct identification of the predictors of these diseases will allow public health actions directed to the reduction of morbidity and mortality and better quality of life of the populations studied. Moreover, studies of the health and well-being indicators of the riverine populations will allow comparisons with future assessments and the possible detection of health system weaknesses (Oliveira et al., 2013).

Our results showed that the prevalence of arterial hypertension in the riverine communities of Tefé and Santa Isabel do Rio Negro were higher than those observed in other investigations carried out in the Amazon region. Studies on the prevalence of arterial hypertension were performed in Belém, State of Pará, in Sinop, State of Mato Grosso and Porto Velho, State of Rondônia. In Belém, the prevalence of arterial hypertension was 13.1% (Andrade et al., 2015), Sinop, State of Mato Grosso, presented prevalence of 23% (Martins, Ferreira, Guimarães, & Vianna, 2010), while in Porto Velho, this index reached 25% (Oliveira et al., 2013). In our study, the prevalence of AH was 28% in Tefé and 30.7% in Santa Isabel do Rio Negro. The high frequency of the disease among the riverine inhabitants of these municipalities, when compared to the investigations carried out in other locations in the Amazon region, suggests that the place of residence is an important factor to estimate the prevalence of the disease (Oliveira et al., 2013). In addition, these results can be explained by the different occurrence of socioenvironmental characteristics, lifestyle and eating habits of riverine populations of Tefé and Santa Isabel do Rio Negro and the other Amazonian populations (Oyebode et al., 2015). In fact, despite the high frequency of arterial hypertension among individuals living in

Tefé and Santa Isabel do Rio Negro, the factors that conditioned for the disease were slightly different. Among the riverine people of Tefé, AH was more frequent in married men over 35 years of age; for the residents of Santa Isabel do Rio Negro the most susceptible included men, 36 years old or more, and with low education. In the latter case, it was observed that the frequency of the disease gradually decreased with the increase in the number of years of study.

The association of AH with sociodemographic variables showed that the prevalence of the disease in men was 2.21 and 2.64 times higher than in women of Tefé and Santa Isabel do Rio Negro, respectively. Although the present study has found an increased prevalence of AH among men, and this result is consistent with previous reports (Rocha-Brischiliari et al., 2014), there are studies that indicated a high prevalence in the women (Andrade et al. 2015). It is important to emphasize that this result - high frequency of AH among women - is commonly obtained in large scale population studies based on self-reported clinical information (Andrade et al., 2015). In these methodological approaches, disease prevalence is higher in women and in the elderly, as these groups seek more preventive health services and have a greater perception of signs and symptoms indicative of diseases, when compared to men and young people (Andrade et al., 2015). Analysis by age group indicated that the prevalence of AH increases with age. The prevalence of AH in Tefé and in Santa Isabel do Rio Negro was, respectively, 2.98 and 3.39 times higher from 36 years when compared to the range of 18-35 years. Aging provides structural and functional changes in the cardiovascular system, predisposing to the development of AH (Martins et al., 2010). The findings of the present study are validated by epidemiological investigations conducted in Brazil (Andrade et al., 2015), in the United States (Marshall et al., 2015) and in European and Asian countries (Doulougou et al., 2016). With regard to schooling, the present study showed a gradual and linear increase in the prevalence of AH due to the low level of education. Individuals living in Santa Isabel do Rio Negro who reported being illiterate presented a frequency of 2.64 times higher of AH when compared to those with higher education. The frequency of the disease reduced to 1.64 in subjects with elementary school. Other studies have already pointed to the influence of schooling as a socioeconomic marker in the prevalence of hypertension, showing that a higher educational level acts as a protective factor against this disease (Martins et al., 2010; Andrade et al., 2015). In relation to the marital status, married individuals, or those who have a companion, presented a correlation 1.8 times higher for the increase in pressure levels when compared with the single individuals. The higher prevalence of AH among married individuals may represent a higher level of family responsibility and thus, a higher risk as well (Galvão & Soares, 2016)

Diabetes mellitus is a chronic disease with high prevalence, several comorbidities associated with acute and chronic complications, and a high rate of hospitalization and mortality (World Health Organization [WHO], 2013). In Brazil, the results of the National Health Survey 2013 indicated that nine million Brazilians had a clinical diagnosis of DM, and a tendency to increase by 25% for the next few years (Iser et al., 2015). In the present study, the prevalence of *diabetes mellitus* reached 28.2% of those investigated in Tefé, and only 8.9% in Santa Isabel do Rio Negro. Such variation in the prevalence of the disease between the two populations may be a reflection of the differentiated presence of the sociodemographic predictors and associated lifestyle for DM. Inequality in the prevalence of cardiometabolic diseases resulting from the differentiated distribution of risk factors has already been reported in a study conducted in urban populations of Belo Horizonte, State of Minas Gerais, in 2010 (Malta et al., 2014a). In Tefé, *diabetes mellitus* was correlated with age and marital status (married); while in Santa Isabel do Rio Negro, the descriptors for this cardiometabolic disease included the low level of education, the regular consumption of tobacco and the masculine gender.

As observed with other chronic diseases, the increase in the prevalence of DM according to age was pointed out by several studies (Iser et al., 2015, Malta et al., 2014a). As age increases, there are gradual changes in metabolism that favor the onset of *diabetes mellitus* (Iser et al., 2015). Associated with metabolic changes, there are also modifiable factors, such as reduction of physical activity and unfavorable eating habits, which contribute to the occurrence of the disease (Costa & Longo, 2012). *Diabetes mellitus* is also more prevalent among people of lower schooling (Iser et al., 2015). The increased prevalence of DM among married individuals may be associated with unfavorable changes in lifestyle, changes in eating habits, and obesity (Cornelis et al., 2014). In the present study, the probability of DM in illiterate individuals was 5.46 times higher when compared to those with higher education. Results from a cohort study conducted in six Brazilian

capital cities demonstrated that the prevalence of DM was lower among adults who did not complete elementary school (Iser et al., 2015). Data from the PNAD 2008 identified a higher prevalence among individuals with up to eight years of schooling than among those with 12 years or more of education (Iser et al., 2015).The fact that the prevalence of *diabetes mellitus* is higher in a population with fewer opportunities for access to health services evidences not only the influence of social determinants on the health-disease process, as well as the impact of the educational level on the knowledge and attitudes taken by the individual in relation to their health (Iser et al., 2015). The increased prevalence of *diabetes mellitus* among men has been reported in national (Schmidt et al., 2014) and international studies (Apovian, 2016). It is worth mentioning the results of a longitudinal and multicenter study in six Brazilian capital cities (Schmidt et al., 2014). In this investigation, the use of biochemical measures in the diagnosis of DM showed that the prevalence of diabetes was 42.6% higher among men (Schmidt et al., 2014). However, the predominance of the disease among men is not a consensus in the literature, mainly when using self-reported information (Iser et al., 2015). With respect to the lifestyle descriptors, the results of the present study pointed to the correlation between tobacco consumption and the increase in DM prevalence in the residents of the municipality of Santa Isabel do Rio Negro. In this population, characterized by low educational level, the prevalence of DM was 7.28 times higher among smokers. Exposure to tobacco is associated with the occurrence of several chronic noncommunicable diseases, such as: cancer, circulatory diseases, respiratory and metabolic diseases (Malta, Oliveira, Vieira, Almeida, & Szwarcwald, 2015). The prevalence of smoking is also influenced by cultural, religious and behavioral factors (Malta et al., 2015). Moreover, uneducated populations have almost twice the prevalence of smoking compared to those with higher education (elementary or higher education) (Malta et al., 2015).

Obesity is a disease with positive associations for several health problems (Phillips, 2016). Data from the Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey, conducted in 26 capital cities of Brazilian states plus the Federal District, between 2006 and 2012, revealed that individuals with increased BMI values had a higher prevalence of self-reported diseases, including dyslipidemias, *diabetes mellitus*, arterial hypertension and stroke (Malta, Andrade, Claro, Bernal, & Monteiro, 2014b). The diseases caused by obesity are a cause for concern among health authorities worldwide (WHO, 2013) and, currently, Brazil experiences the consequences of weight gain among its population, evidenced by health indicators and associated comorbidities (Malta et al., 2014b).The prevalence of obesity showed to be high and significantly different between the riverine populations investigated. Obesity was more frequent among the residents of Santa Isabel do Rio Negro, where the prevalence of the disease reached 42%, when compared to the Tefé riverine population. Such difference in the prevalence of obesity can be justified by the low level of schooling and high sedentary and smoking indices observed in Santa Isabel do Rio Negro. This is consistent with investigations conducted with Brazilian populations (Simões et al., 2015) and worldwide (Kolar, Rodriguez, Chams, & Hoek, 2016). Despite the increased frequency of sociodemographic and lifestyle descriptors, only tobacco consumption was correlated with obesity among the individuals living in Santa Isabel do Rio Negro. In this case, smokers were 3.05 times more likely to gain body weight when compared to non-smokers. Smoking may simultaneously affect lipoprotein lipase activity and increase cortisol levels, leading to fat accumulation in abdominal adipocytes. Compared to total adiposity, central adiposity is more strongly associated with outcomes like dyslipidemia, hypertension and *diabetes mellitus* (da Silva Faria, Botelho, da Silva, & Ferreira, 2012). In Tefé, 22.3% of the adult population presented obesity; and the occurrence of the disease was correlated with increasing age. In fact, the increased frequency of obesity with age is compatible with the increase in the occurrence of cardiometabolic diseases in elderly populations due to the accumulation of risk factors (Apovian, 2016).

The methodological design of the present study has limitations that must be considered in the interpretation of the results: (1) the population investigated is the one that is more available to be found at home, such as retirees and housewives; and (2) the cross-sectional design limits the possibility of interpreting associations found to be derived from cause-effect relationships. However, the use of demographic census information reduced the possibility of bias in this study.

Conclusion

The high prevalence of cardiometabolic diseases investigated in riverine populations reflected the importance of actions aimed at better control of cases of obesity, *diabetes mellitus* and hypertension; establishing goals to increase the degree of

knowledge of these health problems by the riverine populations living in Tefé and Santa Isabel do Rio Negro and also providing these populations with information to prevent the associated factors and thus prevent the onset of cardiometabolic diseases.

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