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Metabolic Syndrome in Quilombola Populations Environmentally Exposed to Organophosphate Pesticides in the State of Pará- Brazil

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***Abstract*— *The quilombola community Médio Itacuruçá in the municipality of Abaetetuba is in permanent contact with Organophosphate pesticides. Knowledge about this environmental exposure and the Metabolic Syndrome (MS) can be especially useful for understanding its impact on human health. Materials and methods: descriptive, cross-sectional study. Sample of 115 individuals, over 18 years old, both genders. Erythrocyte Acetylcholinesterase (AChE) values between 2.6-4.1 IU/mL and butyrylcholinesterase (BChE) values between 1.5-3.5 IU/mL were considered within the normal range. The diagnosis of Metabolic Syndrome (MS) was established according to the Joint Interim Statement protocol. Results and Conclusion: 33% of the quilombola population had MS. In the group with MS, the average value of BChE was 3.60 IU/mL, and in the control group, 3.94 IU/mL. The Mann-Whitnney U test was also performed to define the p-value, getting a result of 0.38. The AChE values were 6.92 IU/mL in the research group and 6.94 IU/mL in the control group, obtaining p-value by the Mann-Whitnney U test of 0.974. Thus, there was a low association between AChE, BChE and MS.*

I. INTRODUCTION

The Metabolic Syndrome (MS) is based on a set of factors that predispose the individual to a greater cardiovascular and metabolic risk, associated with dyslipidemia, insulin resistance, changes in blood pressure levels and central obesity, therefore, representing an influencing factor for the greater cause of global morbidity and mortality, cardiovascular events[7].

In the world, it is estimated that 25% of the population has MS, while in Brazil, there is a prevalence of almost 40% of the entire population[9]. There is a high incidence because of the expanded screening and the vulnerability of part of the inhabitants, because of their socioeconomic and demographic situation, including low education, precarious access to information, insufficient economic power to acquire better nutritional habits, and sedentary lifestyle.[14]

Despite the alarming public health problems represented by MS, its association with pesticides contacts and its impact on human health is not consolidated in the current literature. The consumption of pesticides in agricultural practice intensifies daily, with Brazil being the country with the largest consumer market in the world due to its agrarian system dependent on this usage. As an implication of this rampant practice, it is estimated that a Brazilian citizen consumes, on average, 5.2 kg of pesticides annually.[15] . In addition, in the country, pesticide poisoning represents the second cause of non-communicable diseases in the population, which can increase the rate of general mortality[16].

In Brazil, the main class of agrochemicals used in agriculture are insecticides, represented by three large groups: Organochlorines, Cholinesterase Inhibitors (Organophosphates, Carbamates) and Pyrethroites. The mechanism of action consists of the reversible and irreversible inhibition of the cholinesterase enzyme, depending on the type of pesticide, denouncing an environmental or occupational exposure [3].

The introduction of the National Biodiesel Production Program (PNPB) and the Sustainable Palm Oil Production Program, driven by the state and federal incentive policy in the northeast mesoregion of the Pará state, from the 1980s onwards, introduced the monoculture of palm oil to the region, which uses agrochemicals for cultivation, with the replacement of traditional production activities by palm oil [1].

In general, exposure to pesticides occurs in the environmental form in a chronic way, as the product is sprayed on the plantation. It reaches the population through wind, rain, and groundwater, distributing the agrochemical among individuals.[2]. Thus, representing the need of constant monitoring of air, soil, water, food and biochemical level, which can be primarily detected and exposed. [15]

The quilombola community Médio Itacuruçá is located in the city of Abaetetuba in the state of Pará/Brazil and is located in the territory of Dendê monoculture implantation, where individuals are constantly exposed to Organophosphate pesticides.

According to this context, the objective of the present study was to evaluate adult individuals with Metabolic Syndrome and their respective dosages of Serum and Plasma Cholinesterases, which are used as bioindicators of environmental exposure to Organophosphate pesticides in the quilombola communities of Médio Itacuruçá (Abaetetuba) in the state from Pará. Exalting the importance of studies that clarify the real correlation between MS and agrochemicals usage, what corroborates the development of actions aimed at human health.

II. METHOD

The study was carried out in the Middle Itacuruçá Community, in the city of Abaetetuba at (01º 43’ 04” S 48º 52’ 58” W) located in the northeastern mesoregion of the state and belonging to the Cametá microregion. Because of its far from the main city location, the population suffers from lackage of optimized services, including medical and educational care[17]

The economic activity of this traditional population was based on the acai berry management, which is used to the tiles and bricks production, the cultivation of brazilian arrowroot and other foods. With the introduction of palm oil cultivation, this pattern was replaced, and today its economic activity is based on family agriculture and oil palm monoculture, establishing a strong epidemiological link between occupational and environmental exposure in the region. [4].

The project was evaluated and approved by the Ethics Committee for Research with Human Beings (CEP) of the Instituto Evandro Chagas- Opinion 2,658,533 and CAAE: 80180617.1.0000.0019; preserving the essential and necessary terms for the good ethical conduct of research with human beings.

Adults both sexes, inhabitants of the quilombola community of Médio-Itacuruçá were included, in summary giving 115 cases. Those under 18 years of age, and those whose biological material was not collected or founded incomplete in the analysis were not included.

While describing the clinical and epidemiological profile of the population, the following parameters were used: age, gender, education (illiterate, incompleted/completed primary education, incompleted/completed secondary education and higher education), BMI (Body Mass Index-Kg/m2), supply of water (Public network, Amazon wells, river water, and others), water treatment (chlorination, filtration, boiling or none), occupational exposure to pesticides, knowledge about pesticides, as well as recognizing their possible harm to health; and presence of symptoms of acute intoxication to organophosphates.

The diagnosis of Metabolic Syndrome (MS) was established according to the Joint Interim Statement protocol, which emphasizes the presence of 3 of the following evaluation criteria, simultaneously. 1) increased triglycerides ≥150 mg/dL or usage of drugs to treat hypertriglyceridemia; 2) increased glucose ≥100 mg/dL during fasting blood sugar test or usage of diabetes medication; 3) Decreased HDL <40 mg/dL (male) or <50 mg/dL (female) or usage of drugs to treat low HDL; 4) increased blood pressure to systolic values ≥130 mmHg and/or diastolic values ≥85 mmHg, or the usage of antihypertensive medication; 5) increased waist measurement >90 cm for men and >80 cm for women, using figures suggested for Latin America. The presence of MS defined the division of individuals to the research group, while its absence to the control group.

Exposure to organophosphates was evaluated by considering following laboratory measurement of blood cholinesterases: red blood cells-acetylcholinesterase (AChE) and butyrylcholinesterase (BChE), according to the Modified Ellman method, performed at the Chromatography Laboratory of the Environment Section (SEAMB) from the Evandro Chagas Institute. AChE values between 2.6 and 4.1 IU/mL and BChE values between 1.5 and 3.5 IU/mL were considered within the normal range.

The information obtained from the medical records of individuals with MS was organized in Excel spreadsheets, version 2010, and analyzed using the Epi info program, version 2007, for the preparation of descriptive statistics and a scientific product. The definitive p-value of variables was calculated using two different tests: Fisher's test and Mann-Whitney U test. All statistical tests considered probability (p-value) significant ≤ 0.05. The 95 percent confidence interval was also obtained in variables.

III. RESULTS AND DISCUSSION

While observing the epidemiological profile of the community of 115 quilombola adults from Médio Itacuruçá (TABLE 1), it was clarified that more than half (52.8%) of the population is male. Regarding education, it was observed that most adults in the community (49.5%) did not complete elementary school. This fact refers to the large vulnerability that is present in the population[5].

Regarding knowledge about pesticides (TABLE 2), 67.5% of the population claims not to have it, however, 80.4% that they are conscious that its usage can cause damage to health. Similar situation was found by Riccò (2018) who affirmed that most participants knew that pesticides can lead to health damage connected to occupation (85.0%) and inhabitants who live nearby to the plantations (76.5%), that their usage can cause potentially acute lethal poisoning (90.0%) and chronic injury (71.2%). In addition, eleven of the 115 adults (9.5%) reported having symptoms of acute intoxication.

A set of metabolic alterations characterizes Metabolic Syndrome (MS), usually associated with dyslipidemia, insulin resistance and glucose intolerance, changes in blood pressure and central obesity identified by increased waist measurement[7]. As a matter of absence of specific criteria that are needed to determine MS in a quilombola population, the general criteria referring to the Latin American population were used in that research[8].

Among the 115 adult patients living in the rural area in Abaetetuba (TABLE 3), 33% (38 individuals) presented Metabolic Syndrome, 23 of them were male and 15 were female. In analysis of the prevalence of MS in the Brazilian population, it was discovered that 38.4% of them are MS carriers[9]. In quilombola populations, the value represents 25.8% of adult individuals, in a study by Mussi (2019). In Do Monte (2019) the percentage with MS, obtained according to the criteria of the International Diabetes Federation, was 37.1%. Therefore, in the population of Médio-Itacuruçá community, average values corresponding to the studies were found.

It is important to emphasize that the literature points out divergences regarding the association of MS with sociodemographic, behavioral, environmental, biological factors, and comorbidities, making it difficult to adequately screen and cope with its main predisposing factors[11]. In addition, differences in the prevalence of MS in epidemiological and socially similar populations are explained by the differences between the criteria established for the diagnosis. [8].

The p-value defined by the Mann-Whitney U test (TABLE 3) was calculated, demonstrating a p-value lower than 0.001 in: weight, BMI, waist measurement, systolic and diastolic blood pressure, glucose, triglycerides, HDL. Therefore, very strong evidence was obtained against the null hypothesis in these variables.

The BMI of healthy individuals was 26.44 kg/m2 (95%CI: 25.1-27.7), while those with MS were 32.54 kg/m2 (95%CI: 30.2-34.8). Therefore, the research is in consensus to the literature regarding metabolic syndrome in the adult population, as described in Luo (2020) who affirm that adults with MS had an average BMI of 33.24kg/m2, while those without MS had an average of 26.42kg/m2.

Regarding the values found for Plasma Cholinesterase, the avarage value of 3.60 IU/mL (3.01-4.19) was obtained in the MS group, and 3.94 IU/mL in the control group (3. 49-4.40). The Mann-Whitney U test was also performed to define the p-value, observing a result of 0.381, showing there is no sufficiency evidence that points to the connection between BChE levels and MS appearing. Erythrocyte cholinesterase levels were 6.92 IU/mL (5.49-8.36) in the research group and 6.94 IU/mL (6.21-7.66) in the control group, obtaining p-value by the Mann-Whitnney U test of 0.974, indicating, as in the BChE, low evidence against the null hypothesis, that is, the association between AChE and MS.

According to the results detailed above, in the present study, acetylcholinesterase values did not change with the presence of MS in quilombola patients, thus, the connection between these variables was not observed because there was no statistical significance. Such data are in disagreement with the most recent studies, such as the study carried out by Luo[12](2020) who collected urine samples with organophosphate metabolites, which were positively associated with high chances of the prevalence of MS, as well as its individual factors - waist measurement, blood pressure, blood glucose, triglycerides and HDL - particularly in male gender.

IV. CONCLUSION

The population of the Médio Itacuruça is in a situation of social vulnerability mainly because of undereducated society. In addition, it was observed that a third are classified as having Metabolic Syndrome, reflecting the importance of health measures aimed at reducing this comorbidity, which is linked to cardiovascular morbidity and mortality.

Despite the continuous environmental exposure in which the quilombola community is inserted, the chemical dosage of biomarkers indicative of intoxication was not found to be significant. Regarding the association between MS and the usage of agrochemicals, there was no significant statistical evidence which affirmed the correlation between modification of acetylcholinesterase values with the presence of MS in quilombola inhabitants, which may be associated with the period of collecting the analyzed material and to the spraying period in the region.

The outcome of other larger, more significant population-based studies suggested metabolic dysfunctions caused by exposure to organophosphates and their impact on human health, in addition to the need for frequent monitoring of the population's contact with pesticides by the Environmental Health Surveillance Program.

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ANEXOS

Table 01 – Clinical-epidemiological data of a sample of 115 individuals from the community of Médio Itacuruçá in the municipality of Abaetetuba, Pará, Brazil.

Variables	
Age (Average [CI 95%])	**46,16 [42,9-49,4]**
Gender (%)	
Feminine	**68 (47,2)**
Male	**76 (52,8)**
Education level (%)	
Illiterate	**14 (12,2)**
Incompleted Primary Education	**57 (49,5)**
Completed Primary Education	**05 (4,3)**
Incompleted Secondary Education	**11 (9,5)**
Completed Secondary Education	**27 (23,5)**
Higher Education	**0 (0)**
Weight (Average [IC95%])	**72,9 kg [69,4-76,3]**
Height (Average[IC95%])	**1,60 m [1,58-1,61]**
BMI (Average [IC95%])	**28,45 kg/m² [27,2-29,6]**

BMI – Body Mass Index.

Source: Author's collection.

Table 02 - Data related to exposure to pesticides in a sample of 115 individuals from the community of Médio Itacuruçá in the municipality of Abaetetuba, Pará, Brazil.

Variables	
Knowledge about pesticides (%)	
Yes	**37 (32,5)**
No	**77 (67,5)**
Recognizes the possibility of pesticides causing damage to health (%)	
Yes	**78 (80,4)**
No	**19 (19,6)**
Occupational Exposure to Pesticides (%)	
Yes	**12 (10,5)**
No	**102 (89,5)**
Symptoms of acute intoxication (%)	
Yes	**11 (9,5)**
No	**104 (90,5)**

Source: Author's collection.

Table 03 - Statistical analysis between groups with metabolic syndrome (Case) and without metabolic syndrome (Control) for the sample population of rural residents in the municipality of Abaetetuba, Pará, Brazil.

Variabless*	Controle (n = 77)	Caso (n = 38)	p
Age (CI95%)	**43,0 (39,2-46,8)**	**52,88 (47,0-58,7)**	**<0,001[b]**
Gender (%)			
Feminine	**48 (62,3%)**	**23 (60,5%)**	**1,00[a]**
Male	**29 (37,6%)**	**15 (39,5%)**	
Weight (CI95%)	**67,47 (63,9-71,0)**	**84,4 (77,8-91,0)**	**<0,001[b]**
Height (CI95%)	**1,59 (1,57-1,61)**	**1,61 (1,57-1,65)**	**0,093[b]**
BMI (CI95%)	**26,44 (25,1-27,7)**	**32,54 (30,2-34,8)**	**<0,001[b]**
Waist measurement (IC95%)	**88,4 (84,3-91,6)**	**103,9 (98,7-109,1)**	**<0,001[b]**

Table 03 - Statistical analysis between groups with metabolic syndrome (Case) and without metabolic syndrome (Control) for the sample population of rural residents in the municipality of Abaetetuba, Pará, Brazil.

Variabless*	Controle (n = 77)	Caso (n = 38)	p
Age (CI95%)	43,0 (39,2-46,8)	52,88 (47,0-58,7)	<0,001[b]
Gender (%)			
Systolic Blood Pressure (IC95%)	124,65 (121,2-128,0)	137,0 (131,3-142,6)	<0,001[b]
Diastolic Blood Pressure(IC95%)	80,0 (77,0-82,9)	85,7 (82,3-89,2)	<0,001[b]
Glucose [mg/dL] (IC95%)	79,0 (75,0-83,0)	99,9 (86,1-113,7)	<0,001[b]
Triglycerides [mg/dL] (IC95%)	99,3 (89,1-107,5)	201,2 (171,5-230,8)	<0,001[b]
LDL colesterol [mg/dL] (IC95%)	122,3 (114,5-130,0)	123,3 (112,5-134,6)	0,141[b]
HDL colesterol [mg/dL] (IC95%)	45,7 (43,3-48,0)	32,4 (29,1-35,8)	<0,001[b]
Colinesterase Plasmática (IC95%)	3,94 (3,49-4,40)	3,60 (3,01-4,19)	0,381[b]
Colinesterase Eritrocitária (IC95%)	6,94 (6,21-7,66)	6,92 (5,49-8,36)	0,974[b]

***: Quantitative variables are represented by the sample mean and 95% confidence interval (95%CI) and qualitative variables are represented by the absolute and relative frequency for each category; AChE – Acetylcholinesterase; a: p-value defined by Fisher's exact test; b: p-value defined by the Mann-Whitney U test.**

Source: Author's collection.