GENOTOXIC, HEMATOLOGICAL AND BIOCHEMICAL MARKERS OF HEALTH RISK TO RURAL COMMUNITIES OF THE SANTARÉM AGRICULTURAL REGION, BRAZILIAN AMAZON

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INTRODUCTION

Brazil is one of the largest consumers of pesticides on the planet ("FAO," 2022). The advance of the agricultural frontier of grain monocultures over the Amazon biome entails risks and damage to the environment (Rico et al., 2022) and human health (Fona et al., 2024), which are directly or indirectly associated with the intensive use of agrochemicals (Cezarette et al., 2024). Rural communities in the region of Santarém, in the west of the state of Pará, located on the axis of the BR-163 and PA-370 highways, are potentially exposed to various adverse health risks caused by pesticides (Pires et al., 2020). This study evaluates the sociodemographic, genotoxic, and hematological profile, cholinesterase enzyme activity, and the exposure to glyphosate in individuals from communities on the agricultural frontier of Santarém and Belterra, Pará.

METHODS

This was a cross-sectional, exploratory study with convenience sampling (n=39) in three rural communities on the PA-370 (Quilombo Bom Jardim and Tipizal) and BR-163 (São Francisco da Volta Grande) highways. Sociodemographic and health data were obtained, as well as the distance between homes and plantations and the length of residence in the community. To assess the risk of exposure, blood and urine samples were analyzed and the following biomarkers were assessed: concentration of glyphosate in urine, DNA damage using the comet assay (Tail DNA Percent and Olive Moment), hematological parameters (Mean Corpuscular Hemoglobin Concentration - MCHC and Red Blood Cell Distribution Width - RDW), and cholinesterase activity by cholinesterase (AChE) and pseudocholinesterase (BuChE). The data was tabulated in Excel 365 spreadsheets. Exploratory analyses used dispersion data (mean, standard deviation, standard error) and boxplot graphs. Possible differences were tested by 1-criteria ANOVA. Numerical variables were normalized and subjected to the Pearson correlation test and Principal Component Analysis. The PAST v5.2 program (Hammer et al., 2001) was used for statistical analyses. The research is part of the project 'Environmental Contaminants and Risks of Multiple Exposure in the Brazilian Eastern Amazon', approved by the Research Ethics Committee (CEP) of the Federal University of Western Pará (UFOPA) under opinion no. 6631576.

RESULTS

Among the participants, 66% are women, 87% are aged between 18 and 59, 58% have lived in the community for more than 10 years, and 64% of the homes are located less than 500 meters from cultivated areas (Figure 1A).

A

	N	%
Sex		
Masculine	6	12
Feminine	33	66
Age		
18 – 59 years old	34	87
Over 60 years old	5	13
Residence time		
1 – 5 years	6	12
5 – 10 years	4	8
Over 10 years	29	58
Distance between the plantation and the residence		
Less than 50 meters	15	30
50 – 500 meters	17	34
Over 500 meters	7	14

B

Parameters and categories	Masculine (N=6)		Feminine (N=33)	
	N Mean	% SD	N Mean	% SD
CHCM (23-36g/dL)				
Normal	6	100	33	100
RDW (M=11-14,5/F=11,6-14%)				
Normal	5	83	19	58
Over	1	17	14	42
Cholinesterase (5.320-12.920U/L)				
Normal	6	100	33	100
Pseudocholinesterase (M=4.620-11.500/F=3.930-10.800U/L)				
Normal	6	100	33	100

Caption: M= Masculine; F= Feminine; SD= Standard Deviation.

Figure 1. (A) Sociodemographic characteristics of those sampled, (B) Categories of hematological parameters and cholinesterase activities according to sex.

Human exposure to glyphosate was observed in all participants. DNA damage is lower in residents living more than 500 meters from the plantation, however, the difference compared to groups living less than 500 meters is not significant: DNA Olive Moment (F=1.706; p 0.196; GL=37), % Tail DNA (F=0.604; p=0.552; GL=38). In contrast,

the greatest DNA damage is observed in the oldest residents (over 10 years) (Figure 2A-B). The hematological parameters show little variation depending on the length of residence and the distance between the residence and the plantation (Figure 2C-D). Although there is no clear difference in the variation of biomarkers between the communities, DNA damage, the CHCM index, and the concentration of cholinesterases are higher in individuals from the Quilombo Bom Jardim and Tipizal communities (Figure 2E).

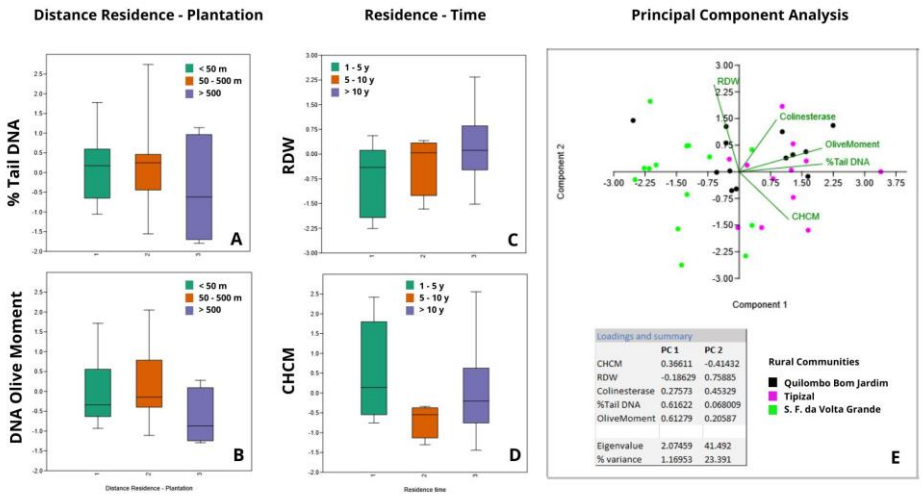

Figure 2. Variation in the hematological, biochemical, and genotoxicity parameters of the sample. Distance Residence - Plantation: (A) % Tail DNA, (B) DNA Olive Moment; Residence - Time: (C) RDW, (D) CHCM; (E) Principal Component Analysis of parameters.

DISCUSSION

The Santarém agricultural region is a hotspot for the advance of large-scale agriculture in the Amazon biome. In the region, the scenario favorable to agribusiness benefits from the supply and availability of land, as well as the implementation of major infrastructure and logistics projects, such as the paving of highways, the construction of ports, and navigability. The regular use of agrochemicals in soy and corn monocultures has the potential consequence of chemical pollution of the environment. Glyphosate and AMPA residues have already been detected in the surface waters of streams in the Santarém region (Pires et al., 2020). The presence of glyphosate and the variation observed in hematological and genotoxicity biomarkers (this study) point to evidence of a health risk for the inhabitants of rural communities in western Pará. Exposure to pesticide residues in the study area seems to be independent of the length of time living in the community and the distance from homes to farming areas.

CONCLUSION

Human exposure to glyphosate was detected in all those sampled. Alterations in hematological and genotoxic parameters were observed in recent residents (less than 5 years) and those living more than 500 meters from the plantation areas. Environmental management measures and public health actions are essential for monitoring and mitigating the adverse impacts associated with the deleterious and chronic effects of environmental glyphosate exposure.

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