Impact of Gold Mining on Cytogenetic Alterations and Exposure to Complex Elemental Mixtures: A Study in the Population of Nechí, Colombia

Alicia Humanez Álvarez[1]; Karina Pastor-Sierra[1]; Lyda Espitia-Pérez[1]; Ana Peñata-Taborda[1]; Osnamir Elías Bru-Cordero[2]; Claudia Galeano-Páez[1]; Pedro Espitia-Pérez[1]; Hugo Brango[3]; Dina Ricardo-Caldera[4], Gean Arteaga-Arroyo1.

[1] Grupo de Investigación Biomédica y Biología Molecular, Universidad del Sinú, Montería, Córdoba, Colombia.
[2] Departamento de Matemáticas y estadística, Universidad Industrial de Santander, Bucaramanga, Santander, Colombia.
[3] Departamento de Matemáticas y Estadística, Universidad de Sucre, Sincelejo, Sucre, Colombia.
[4] Grupo de Investigación en Enfermedades Tropicales y Resistencia Bacteriana, Universidad del Sinú, Montería, Córdoba, Colombia.

ABSTRACT

INTRODUCTION: Gold mining in Latin America, particularly in Colombia, has seen significant growth, positioning the country as the 24th largest global producer and 7th in the region. However, artisanal and small-scale gold mining (ASGM) stands out as the primary global consumer and emitter of mercury, generating complex chemical mixtures with adverse health effects on exposed populations and nearby communities. Despite recognition of these impacts, available information remains limited. **OBJECTIVE:** This study aimed to analyze chemical exposure and its relationship with cytogenetic alterations in the population of Nechí, Antioquia, Colombia, one of the country's most significant mining regions. **MATERIALS AND METHODS:** The study included 205 participants from the Bagre-Nechí mining district and a non-exposed population. Cytogenetic damage was assessed using the cytokinesis-block micronucleus assay (CBMN-Cyt), while chemical concentrations in human hair samples were determined through inductively coupled plasma mass spectrometry (ICP-MS). A Poisson regression model adjusted for covariates was employed, with MNBN frequency as the dependent variable, to explore the influence of gold mining exposure and chemical elements on genetic instability. **RESULTS:** Chemical concentrations were significantly higher in mining zones. Increased chromosomal instability was observed in the Nechí population (PR=2.86, 95% CI: 2.162–3.780), evidenced by elevated MNBN frequencies compared to the reference

group. Occupational exposure emerged as a modulating risk factor associated with higher MNBN frequency (PR=0.93, 95% CI: 0.724–1.19). Toxic elements such as Hg (PR=0.997, 95% CI: 0.959–1.037) and As (PR=1.414, 95% CI: 0.435–4.601) showed significant risk effects. Moreover, interactions with elements like Se (PR=1.07), K (PR=1.02), and Ca (PR=1.00) were identified as relevant for genetic instability biomarkers. Cd (PR=6.17) and Ce (PR=4.6) were prominent modulators, exceeding the effects of traditional toxicants like Hg and As in this mining area. **CONCLUSION:** This study highlights the health effects of chemical exposure in mining regions, emphasizing the need for an integrative approach to risk assessment, particularly in communities with occupational mining exposure.

KEYWORDS: Elemental mixtures, Environmental exposure, Occupational health, Micronucleu, ASGM.

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