

Prenatal and Adolescent Heavy Metal Exposure and Rubella Immunity in a Nepal Birth Cohort

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Introduction

- Heavy metals occur naturally in the environment, but anthropogenic activities can increase their accumulation in water, soil, and homes. Some metals such as zinc (Zn) are essential micronutrients, while others including arsenic (As) and lead (Pb) are toxic and associated with cancer, neurodevelopmental disorders, and immune dysfunction.
- Environmental exposures may influence vaccine-derived immunity.
- This study examined associations between prenatal and adolescent metal exposure (As, Pb, Zn) and rubella antibody titers in adolescence in a birth cohort from Chitwan, Nepal.

Methods

Study Population

- Participants were recruited from the Chitwan Birth Cohort in Bharatpur, Nepal (established 2007). Mothers were enrolled at delivery and cord blood samples were collected.
- At ages 14–15, participants were visited at home where blood and urine were collected.

Exposure Analysis

- Heavy metals were measured using inductively coupled plasma mass spectrometry (ICP-MS).
- Rubella IgG antibodies were measured from dried blood spots using enzyme-linked immunosorbent assay (ELISA).

Statistical Analysis

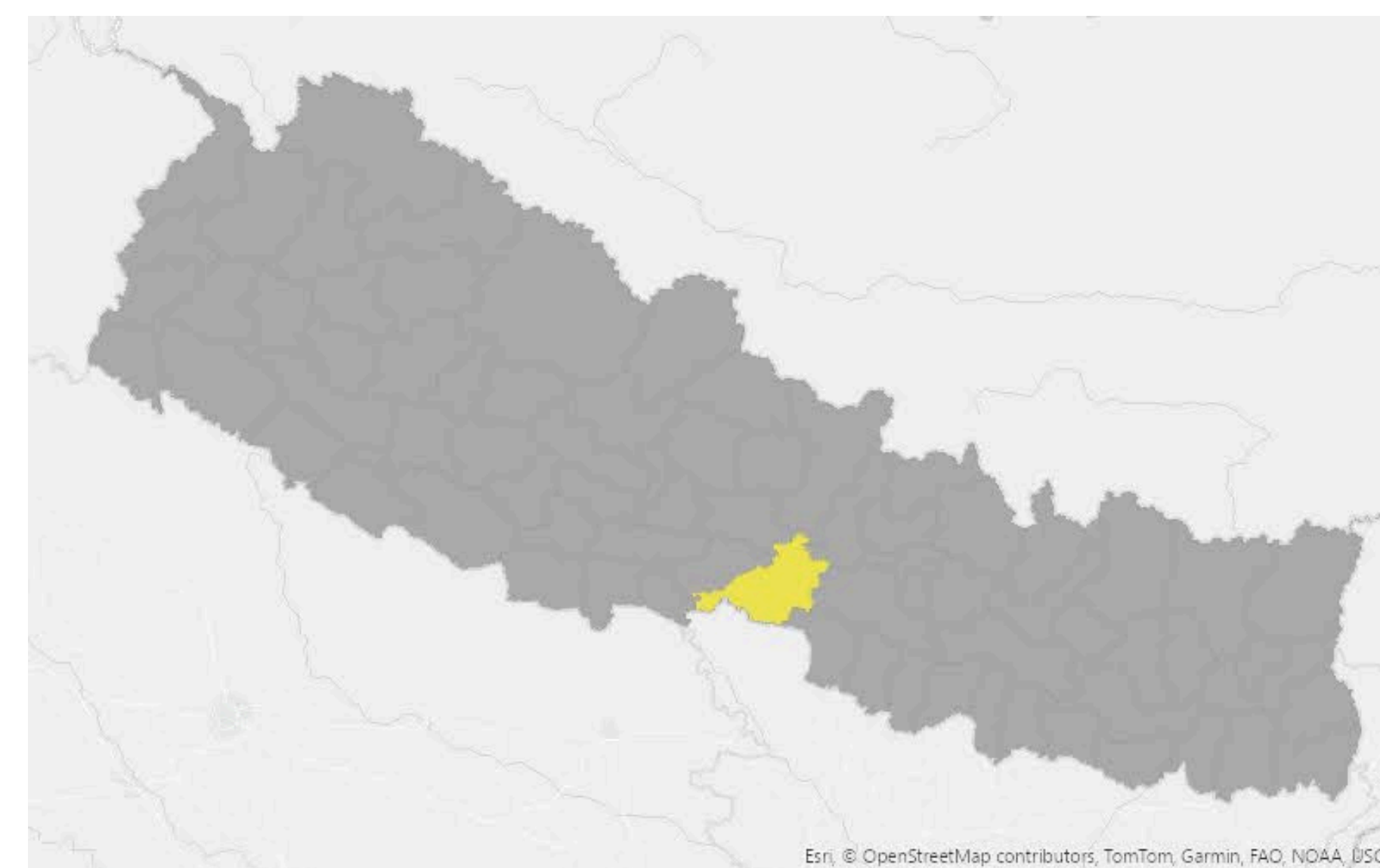
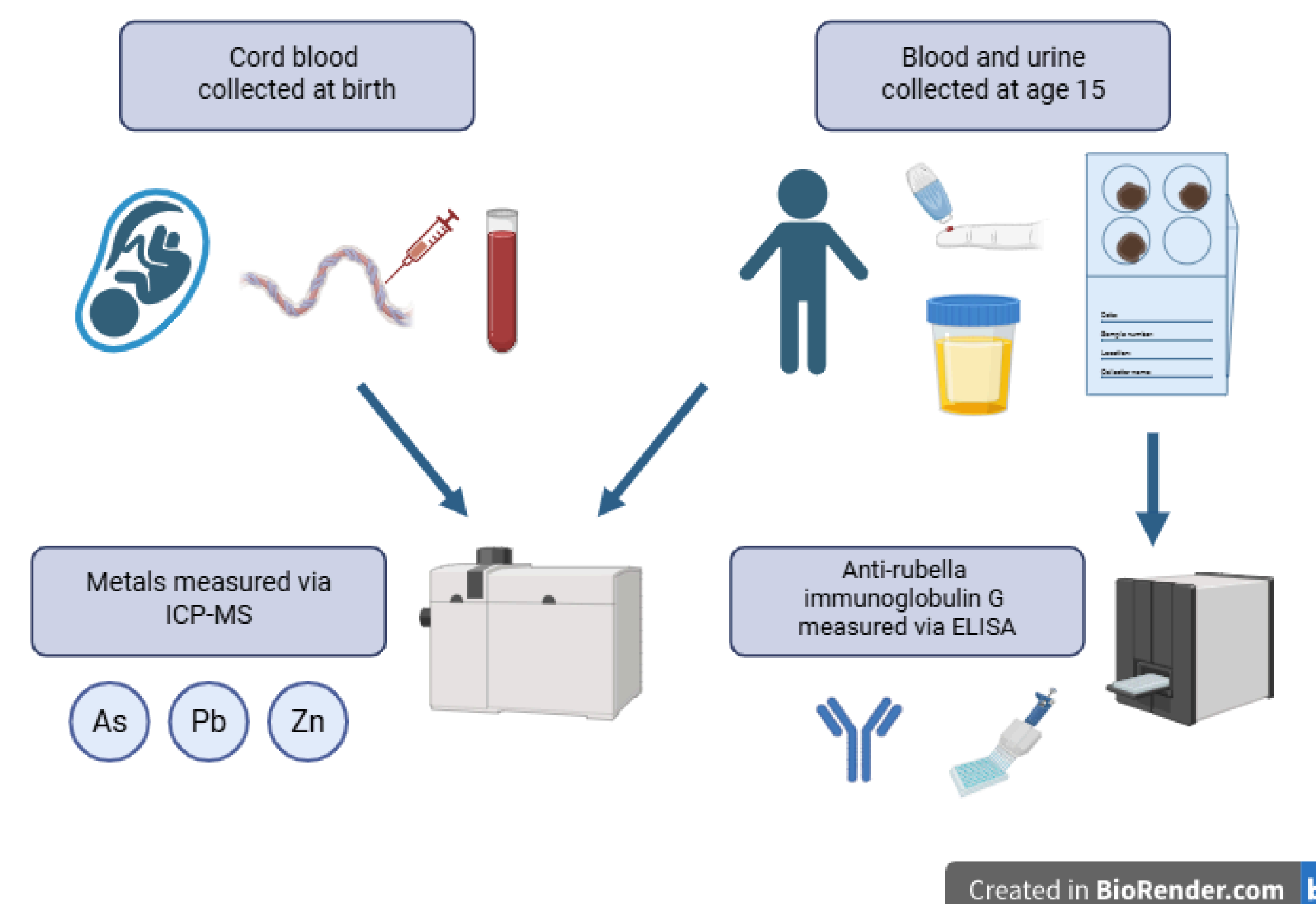
- Associations between metal exposure and rubella antibody titers were examined using multivariable linear regression models in R (v4.5.2).

Results

- n = 73 adolescents
- 94.4% seropositive for rubella antibodies
- Mean cord blood metal concentrations ($\mu\text{g/L}$): As: 1.33 | Pb: 19.48 | Zn: 2104.00
- Mean urinary metal concentrations ($\mu\text{g/L}$): As: 20.44 | Pb: 0.61 | Zn: 345.00

Regression Results

- Higher cord blood zinc was associated with slightly lower rubella antibody titers in adolescence ($\beta = -0.04$, $p = 0.04$). The association remained similar after adjustment for BMI and sex.
 - The estimated association strengthened after removing three potentially influential observations based on Cook's distance ($\beta = -1.18$, $p = 0.02$).
- No associations were observed for arsenic or lead.



(Upper left) Authors RP & SB survey a participant and label collected samples
(Upper right) Visualization of biological specimen collection and analysis
(Lower left) Map of Nepal indicating the location of Chitwan District in yellow



(Lower middle) Authors LW & RP collecting a blood sample from a Chitwan Birth Cohort participant
(Lower right) Author HA performing ELISA to measure rubella antibodies in blood samples

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Rubella immunity was **high** in this cohort- 94% seropositivity.

Arsenic and lead showed **no associations with immunity.**

Cord blood **zinc** had slight **inverse association with antibody titers.**

Exploratory findings warrant further **metal and micronutrient analyses.**