Altitude and anemia prevalence A socio-geographic analysis from 3 districts of Nepal

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Global Envirotech Initiative

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Bio Summary

Leela Khanal is a public health expert from Kathmandu, Nepal, with over 30 years of experience in social behavior change, risk communication, and community engagement in maternal, newborn, and adolescent health. She has worked with organizations like Save the Children Norway, UNICEF Nepal, and JSI, collaborating closely with the Government of Nepal on key initiatives such as the Birth Preparedness Tools and use of Misoprostol for postpartum hemorrhage. She also led the Chlorhexidine ‘Navi’ Care Program, helping scale newborn cord care nationally and internationally. Leela holds Master’s degrees in Public Health and Sociology/Anthropology and currently consults for JSI, GEI and others.

Disclosure Statement

No personal conflicts of interest or relevant financial relationships to report.

ANEMIA in Nepal

- Anemia affects over 40% of WRA in Nepal (BMJ 2021)
- Distribution of anemia is not uniform but highly dependent on the region
- Generally, the Terai region has the highest prevalence
- Effect on physical and cognitive development, economic productivity and maternal-neonatal health outcomes

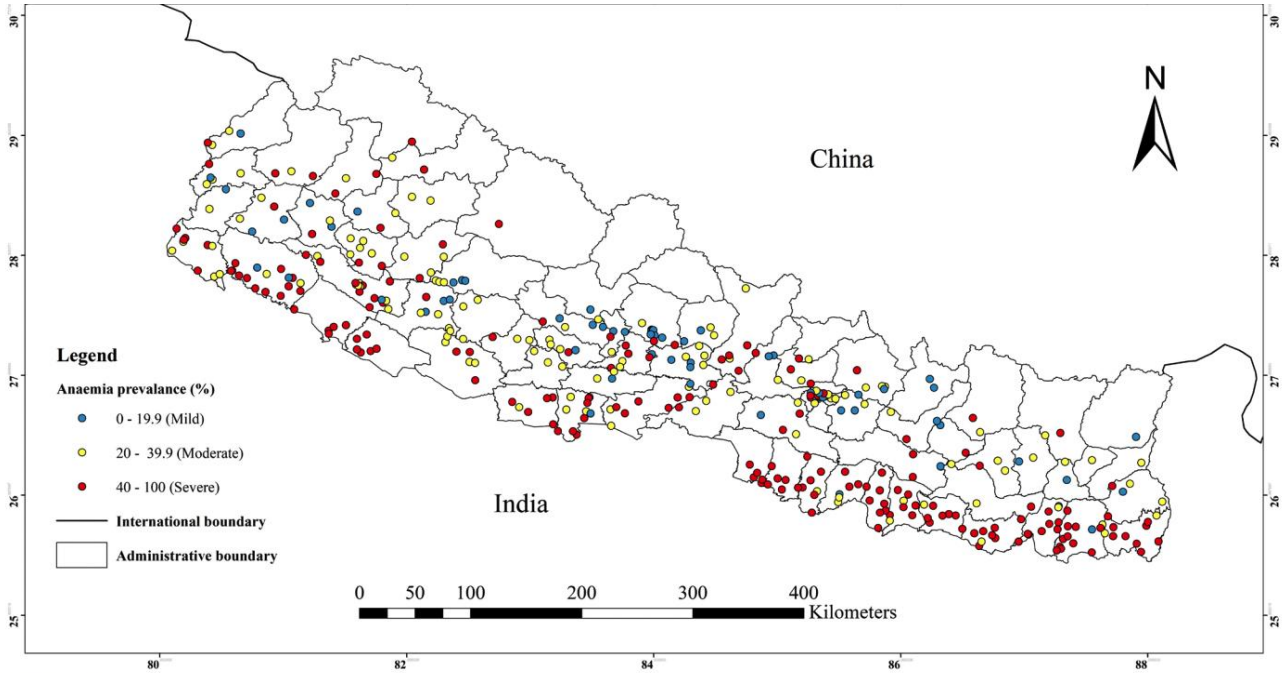

Figure 2 Study area map and observed anaemia prevalence among women of reproductive age for the NDHS survey clusters. NDHS, Nepal Demographic and Health Survey.

2024 - WHO diagnostic standards for anemia

Population	Haemoglobin concentration (g/L)			
	No anaemia	Mild anaemia	Moderate anaemia	Severe anaemia
Children, 6–23 months	≥105	95–104	70–94	<70
Children, 24–59 months	≥110	100–109	70–99	<70
Children, 5–11 years	≥115	110–114	80–109	<80
Children, 12–14 years, nonpregnant girls	≥120	110–119	80–109	<80
Children, 12–14 years, boys	≥120	110–119	80–109	<80
Adults, 15–65 years, nonpregnant women	≥120	110–119	80–109	<80
Adults, 15–65, years men	≥130	110–129	80–109	<80
Pregnancy				
First trimester	≥110	100–109	70–99	<70
Second trimester	≥105	95–104	70–94	<70
Third trimester	≥110	100–109	70–99	<70

Guideline on haemoglobin cutoffs to define anaemia in individuals and populations. Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO.

- Initially developed in 1968
- Revised in 2024
- **Normative values and cutoffs apply to populations that live <1,000m altitude**

Adjustments of measured hemoglobin values are recommended for higher altitude residents

Background: Hemoglobin values and altitude correction

Table 4. Adjustments to haemoglobin concentration (g/L) in 500 m increments in elevation[a]

Elevation range (metres above sea level)	Adjustments in haemoglobin concentration (g/L)[b]
1–499	0
500–999	4
1000–1499	8
1500–1999	11
2000–2499	14
2500–2999	18
3000–3499	21
3500–3999	25
4000–4499	29
4500–4999	33

[a] Adjustments are the amount subtracted from an individual's observed haemoglobin level or added to the haemoglobin cutoff defining anaemia (in g/L).

[b] Proposed adjustments for all population groups based on the equation: Haemoglobin adjustment (g/L) = (0.0056384 x elevation) + (0.0000003 x elevation^2).

Guideline on haemoglobin cutoffs to define anaemia in individuals and populations. Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO.

- Exposure to high altitude >1,000m stimulates production of red blood cells
- Prolonged exposure (weeks) leads to an increase in RBC and hemoglobin
- High altitude residents have higher hemoglobin levels
- **Currently, altitude correction is rarely applied. May play a significant role in Nepal**

Aim and Objectives

AIM

Investigate the association between geography altitude and social/ethnic factors on rates and severity of anemia

OBJECTIVES

1. Describe rates of anemia in different populations in 3 districts of Nepal
2. Investigate the impact of applying the WHO altitude correction for measured HgB levels on anemia diagnosis and severity

Methods Data collection

HEALTH FAIRS – SCREENING EVENT

- Several locations within the municipality (areas of high population density)
- Conducted by local healthpost staff in coordination with municipality and local NGOs
  - Humla: Sarkeghat RM
  - Nuwakot: BelKotghadi M
  - Solukhumbhu: Pasang Lhamu RM

TARGET POPULATION

- Original target population: WRA – aged 15-49 years
- Actual population screened: all ages and genders

DATA ELEMENTS recorded

- Very limited due to volume
- Basic demographic information
- Pregnancy status
- HgB value (Diaspect portable HgB measurement device, CE and FDA approved)

APPROVALS

Approvals – health fair

- SWC approval
- Municipality approval

Approval analysis of data

NHRC

Methods – Data elements

DATA USED FOR ANALYSIS

- Abstracted medical record data (paper records) created during health screening events
- Altitude data added during analysis based on residence

MEASURED HGB AND ALTITUDE CORRECTION APPLIED

- HgB value adjustment according to WHO correction table

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ANALYSIS

Descriptive Statistics: Summary statistics were computed for hemoglobin levels, altitude, and demographic factors

Fisher Exact test was conducted to determine significance when examining the relationship between altitude and hemoglobin levels

GLOBAL ENVIROTECH INITIATIVE ASIA

- **Technical advisor for municipalities and local NGOs**
- Focus on perinatal care, MCH

Global Envirotech Initiative

RESULTS: Patient population and characteristics

Population screened: n=2647

Selected for analysis: n=2639
(complete dataset)

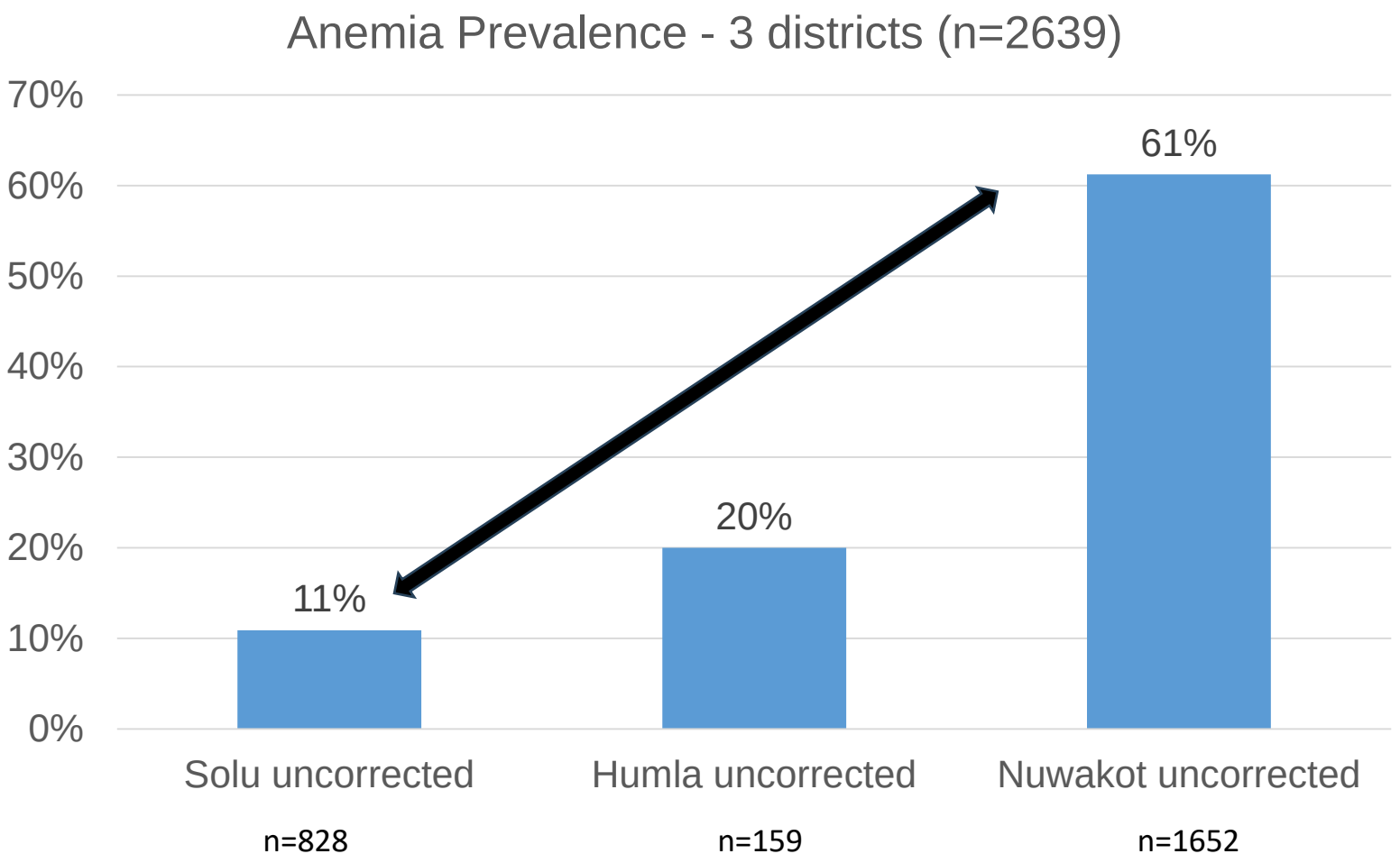
ALTITUDE OF RESIDENCE (M)	PATIENTS All districts
3500 - 4,000	532
3,000-3,500	297
2,500-3,000	n/a
2,000-2,500	n/a
1,500-2,000	1033
1000-1,500	677
<1,000	127

DEMOGRAPHICS	Humla (n)	Nuwakot (n)	Solukhumbhu (n)
Children under 5 male	18	53	27
Children under 5 female	5	64	34
5-10 years male	3	137	121
5-10 years female	2	208	103
10-18 years male	0	145	127
10-18 years female	6	394	145
15-49 y females WRA	134	466	164
All male	18	516	367
All female	141	1042	410
TOTAL	**159**	**1652**	**828**

CASTE	Humla	Nuwakot	Solukhumbhu
Janjati	25 (16%)	565 (33.61%)	763 (92%)
Tamang	0	346 (20.5%)	37 (4.5%)
Sherpa	0	0	359(43%)

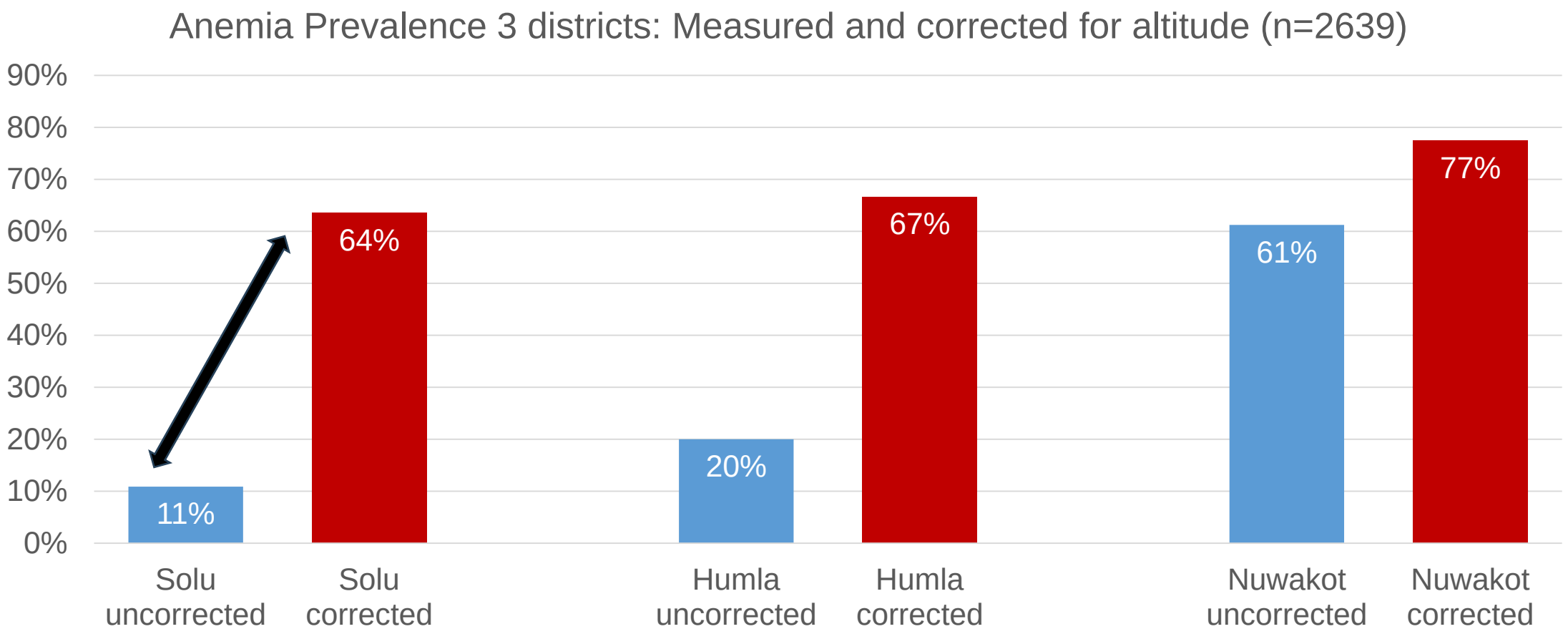
Rates of Anemia differ significantly between districts

All ages and genders



HgB measurement data WITHOUT altitude correction

Altitude correction applied

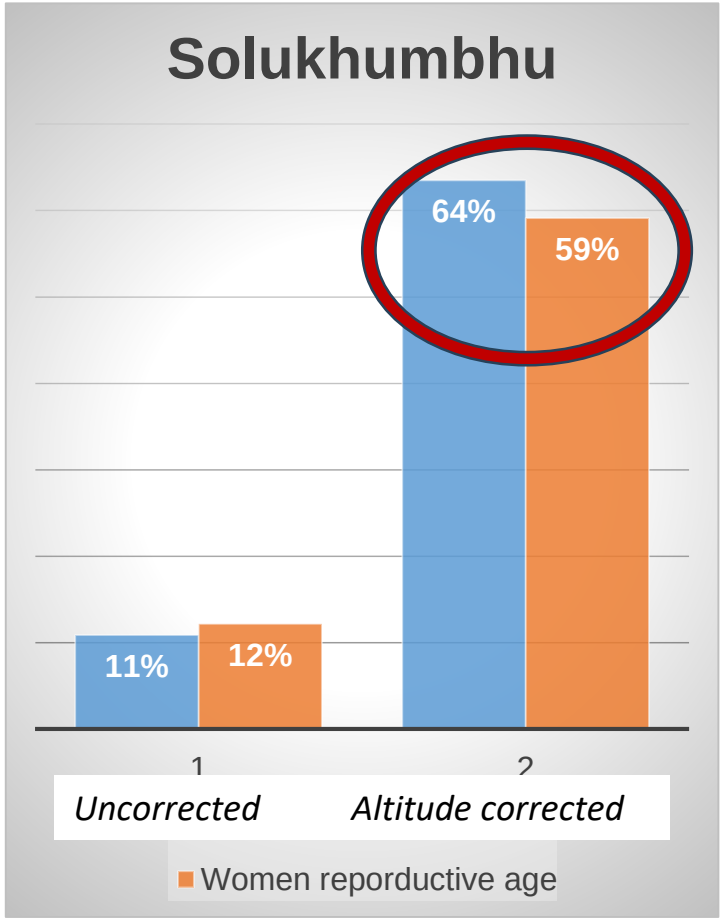


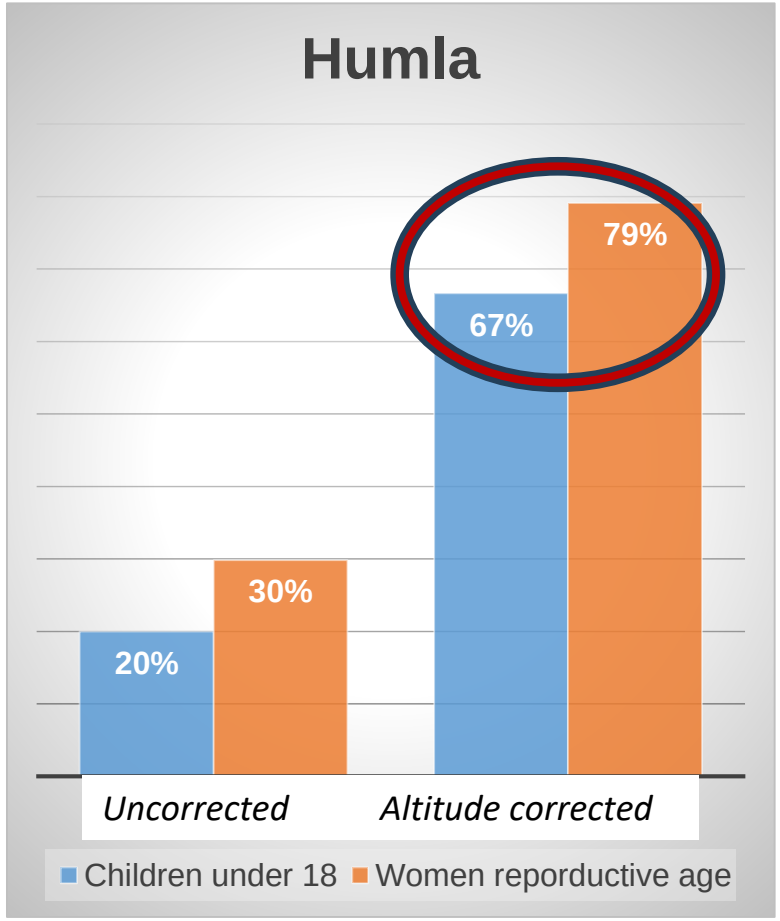
n=828 P<0.01

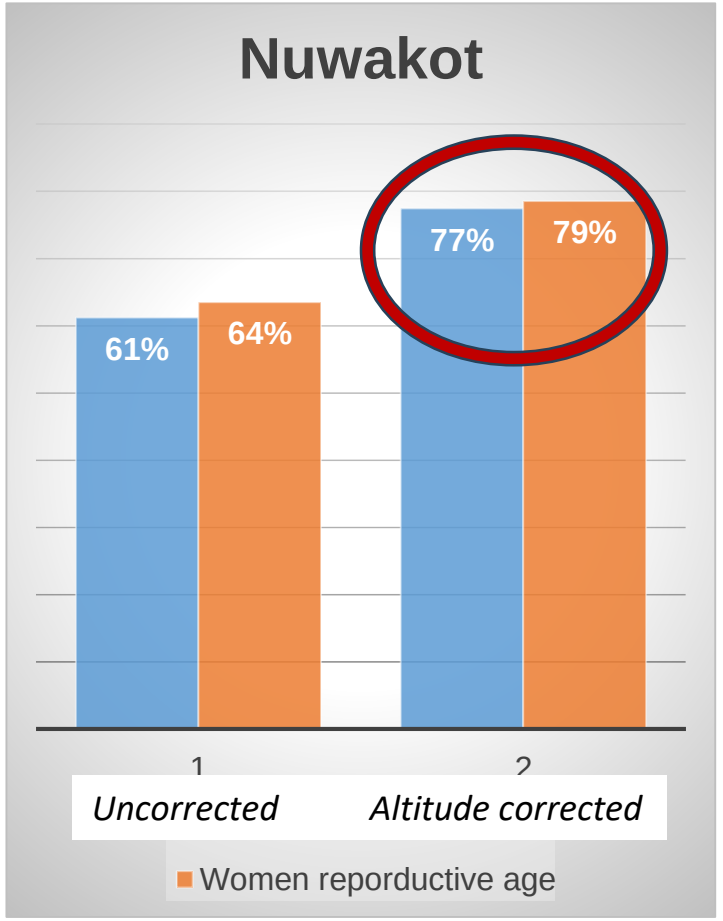
n=159 P<0.01

n=1652 P<0.05

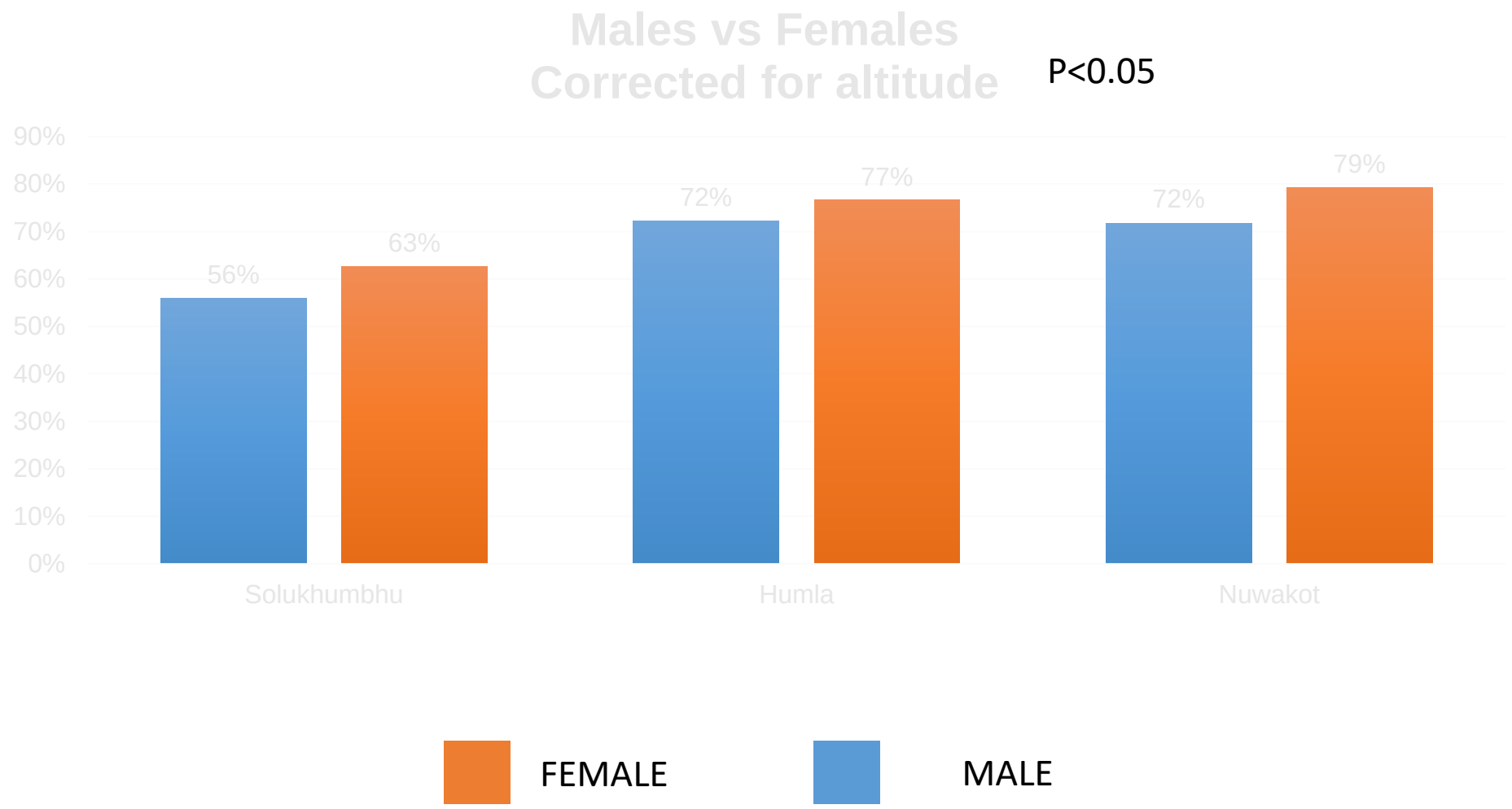
Children under 18 & Women of Reproductive Age







Rates of Anemia: Males vs. Females



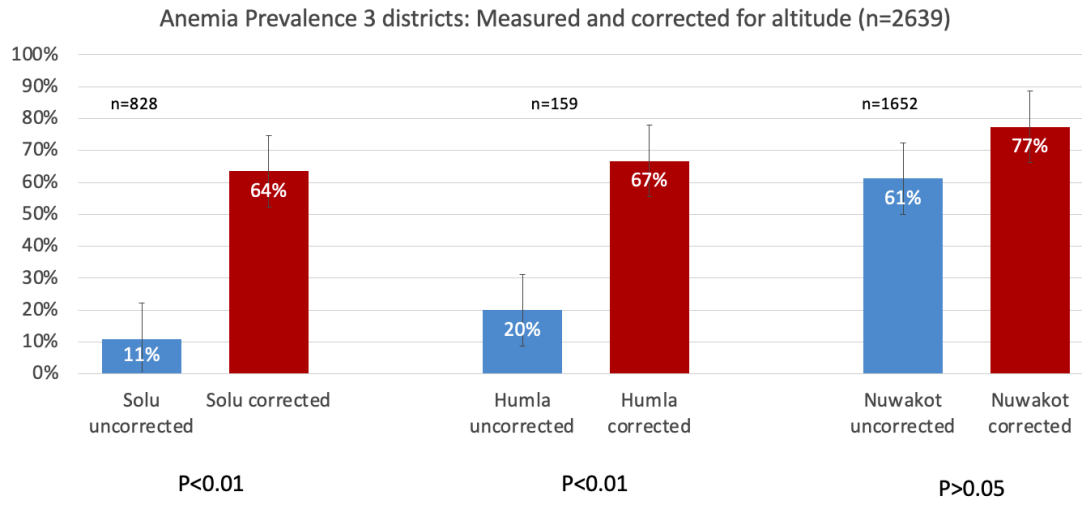
Discussion

ALTITUDE CORRECTION HAS A HUGE IMPACT ON THE DIAGNOSIS and MANAGEMENT OF ANEMIA

Are we under-diagnosing anemia because we do not take altitude into account?

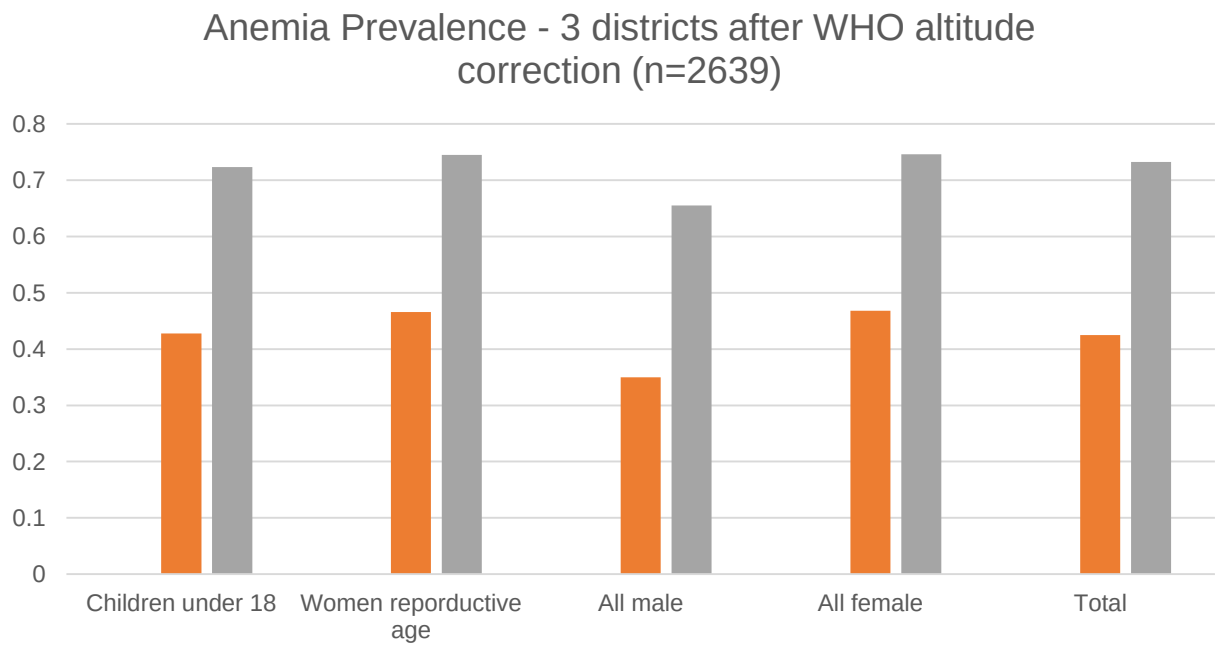
- Many community based anemia initiatives currently do not altitude adjust measures HgB levels to make diagnostic and treatment decisions

- This aligns with findings by Cohen & Haas (1999), who found that without WHO altitude corrections, there is an underestimation of anemia in high-altitude pregnancy cases



Discussion: Anemia affects the entire family

- Traditional focus on WRA and pregnancy
- Anemia also affects also males in target communities
- If service is available, high demand of testing irrespective of gender



Next steps and future considerations

Field testing of non-invasive portable point of care HgB measurement solutions

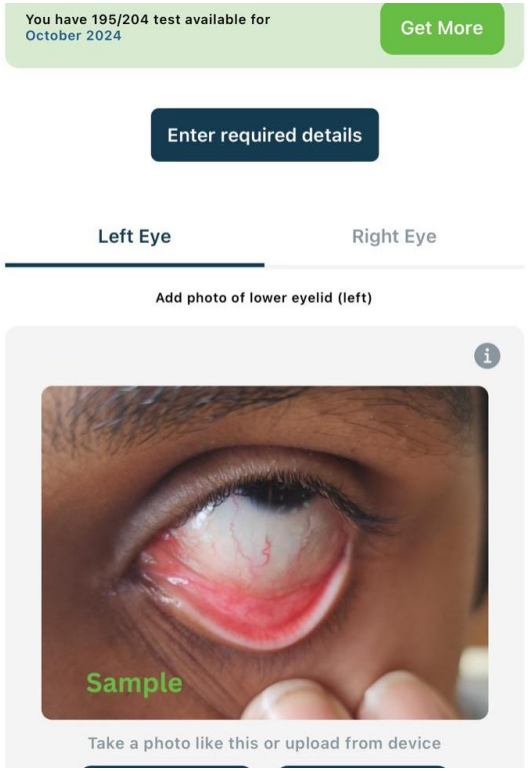
- Community based
- Serial testing

Explore culturally and medically feasible effective ways of iron supplementation

- Target entire family

Investigate causes of anemia

- Lack of information of body iron stores
- Hemolytic diseases



Limitations

- Not designed as a research study a priori
- Only basic demographic variables
- Convenience sampling: unequal distribution of patients included between districts
- Not all places of residence where patients are coming from have a known and recorded altitude.
  - We used the altitude of the testing site as reference
  - Only small effect on overall results
- No social and other qualitative information available

Thank you