

Oxygen saturation (SpO₂) in children living at high altitude.



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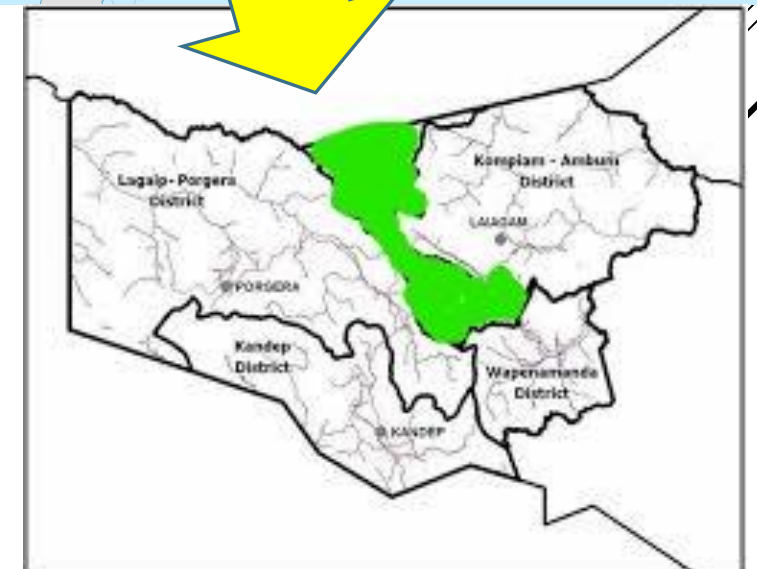
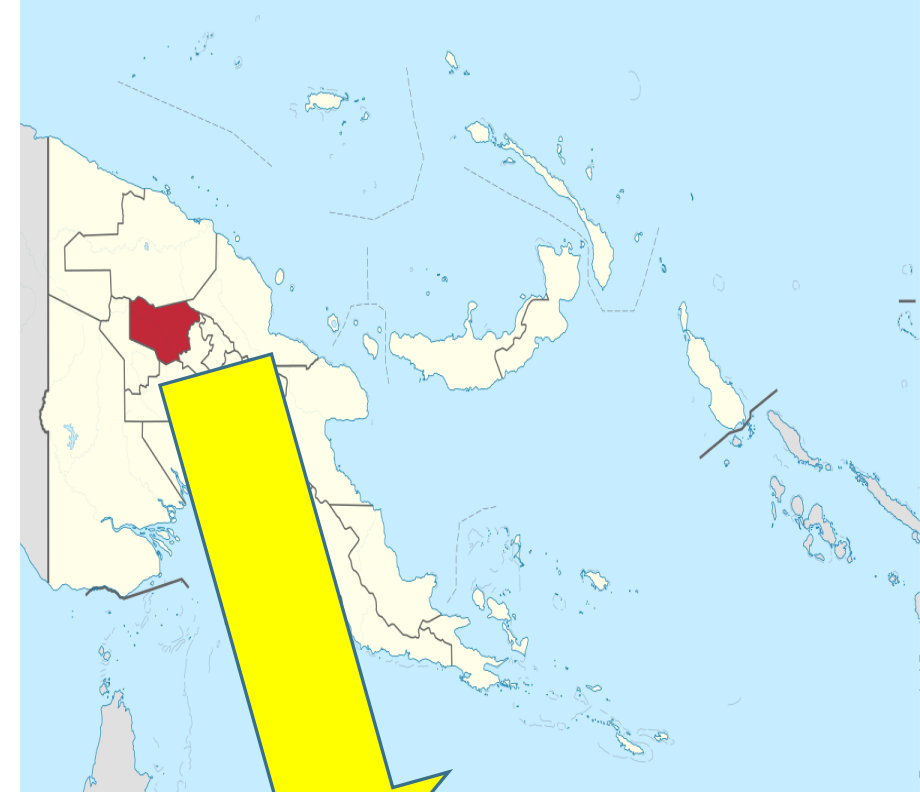
INTRODUCTION

- **Measuring oxygen saturation with a non-invasive pulse oximeter is now becoming a fifth pediatric vital sign used in assessing pediatric patients.**
- **Pulse oximeters, non-invasive, easy to use, giving in second the amount of oxygenated Hb.**
- **Healthy individuals at sea level have SpO₂ values of 95-100%.**
- **Clearly, Arterial O₂ saturation declines with increasing altitude. But what constitutes a “NORMAL” saturation for a given elevation is not entirely clear**



INTRODUCTION

- **Wabag district in Enga Province is in the highland of PNG. At Altitude of 2803m above sea level.**
- **Often few inpatients having no signs of respiratory distress, are clinically stable seem to have Oxygen saturations < 90%. Casing a dilemma, IS IT SAFE TO DISCHARGE?**
- **Or there might be other risk factors pertaining a patient to have a lower saturation. Like, passive smoking, indoor fire burning, early weaning, patients actual age in months since the lungs are still maturing...These relations might contribute to the increased susceptibility of infants to having lower oxygen saturations.**



LITERATURE REVIEW

Several studies have shown that Oxygen saturations in differ at high altitude in pediatric group.

- ▶ Lozano JM, Duque OR et al. Pulse Oximetry reference values at high altitude. Archives of Disease in Childhood 1992; 67:299-301
- ❑ **oxygen saturation range were lower than those reported from children at sea level**
- ▶ Gamponia MJ, Babaali H et al. Reference values for pulse oximetry at high altitude. Arch Dis Child 1998; 78: 461-465.
- ❑ **younger children had a lower oxygen saturation than older children living at high altitude**
- ❑ **Sleep had a lowering effect on oxygen saturation**



LITERATURE REVIEW

Saturation study done in PNG, Goroka

- ▶ T. Duke, J. Mgone, D. Frank. Hypoxaemia in children with severe pneumonia in Papua New Guinea. INT J TUBERC LUNG DIS 5(6):511-519
- ✓ **151 healthy children had mean SpO₂ 95.7% (SD 2.7%)**
- ✓ **Liberal O₂ therapy guided by pulse oximetry may reduce mortality**
- ▶ T Duke, A J Blaschke, S Sialis, J L Bonkowsky. Hypoxaemia in acute respiratory and non-respiratory illnesses in neonates and children in a developing country . Arch Dis Child 2002;86:108–112
- ✓ **Mean SpO₂ for neonates were lower than older children**
- ✓ **In non-ALRTI illnesses hypoxaemia greatly increases the risk of death**



AIM/OBJECTIVES

- ▶ **To determine normal oxygen saturation reference values in healthy children from 1 month to 60 months, living in Wabag District**
- ▶ **Identify risk factors that contribute to lower saturation value in a normal child.**



METHODOLOGY

- Study design:
Descriptive Observational Study
- Study participants:
1 month old to 60 months old (completed months)
- Sample size:
266 healthy individuals
- Study site:
Wabag Hospital MCH clinic;
MCH clinic visit sites: Birip; Akom; Yokomanda; Kwimas; Rakamanda
- Study period:
April 2020 to July 2020

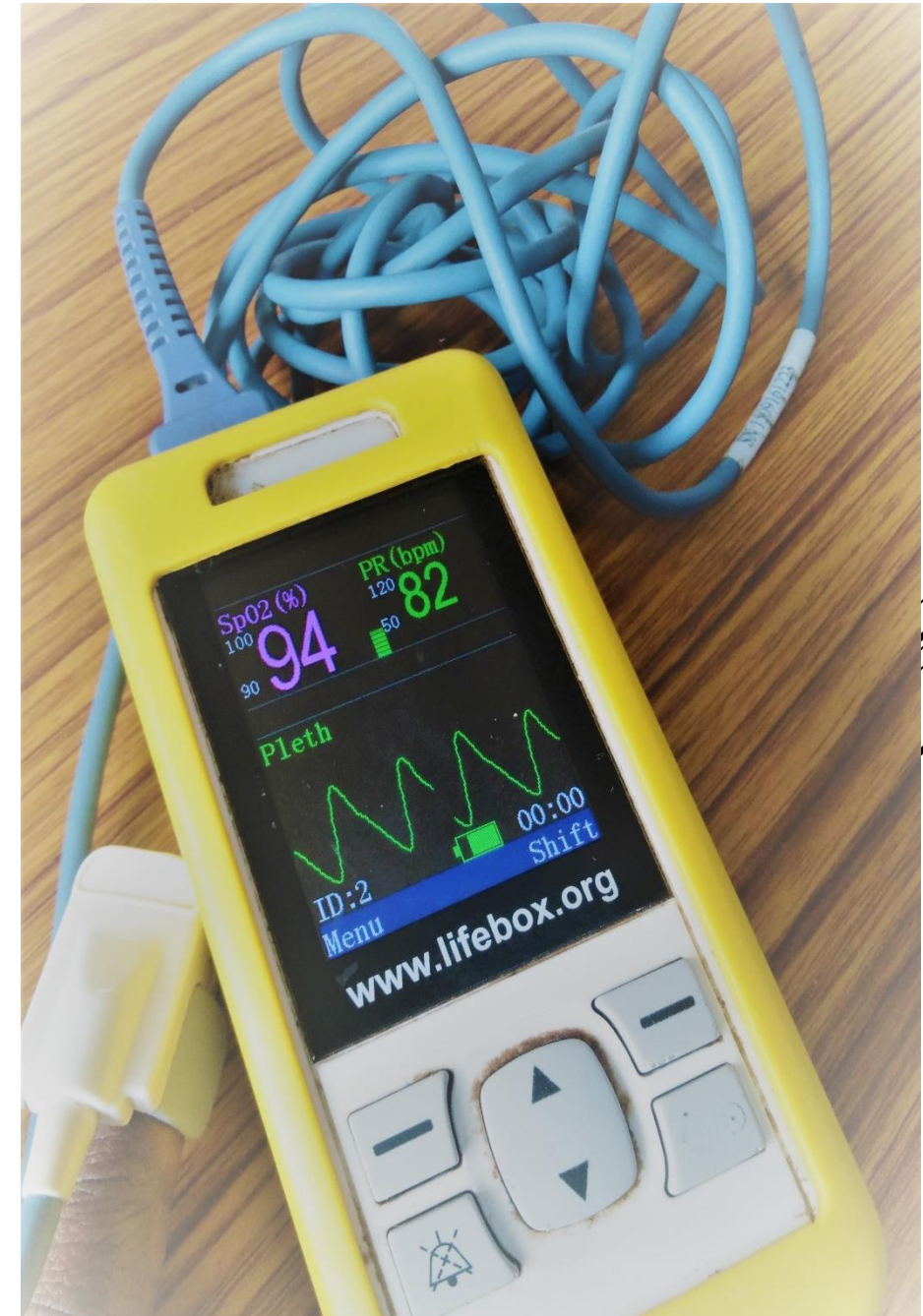


METHODOLOGY

- ▶ Questionnaires filled out
- ▶ Handheld Pulse Oximeter Model No. AH-M1 **used on the patient's index, thumb or large toe of each subject.**

It took at least 1 minute or less until a regular wavelength and constant pulse rate was achieved.

- ▶ **Statistical analysis:** Excel, Epiinfo 7 and STATA version 16



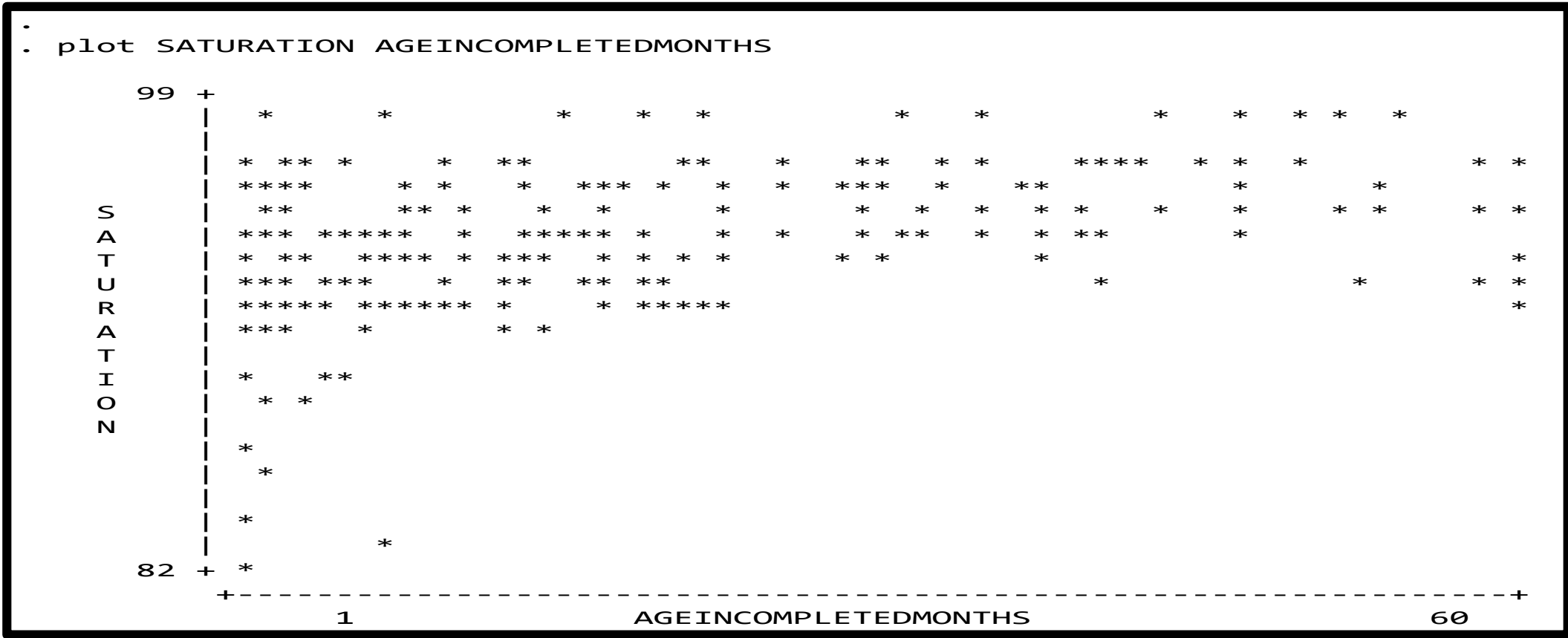
RESULTS

DISTRIBUTION OF SUBJECTS ACCORDING TO AGE AND GENDER

Age in completed months	No.	Mean SpO ₂	SD
1-3	64	93.4	2.9
4-6	21	94	2.6
7-12	40	94	2.5
13-24	61	95.2	2.2
25-60	80	96.7	1.7
MALE	142	94.8	2.8
FEMALE	124	94.85	2.8
TOTAL	266	94.8	2.8

- ▶ Among 266 infants, the SpO₂ was 94.8 (SD: 2.8), range 82-99%.
- ▶ IQR: 93%-97%





> Younger infants had lower saturation than older children.

RESULTS: RISK FACTORS THAT AFFECT SATURATION

Risk factors	N=266 cases	Mean SpO ₂
Asleep	35	92.7
Awake	231	95.1
Inside Bilum (awake/asleep)	55	92.9
Not in bilum	211	95.3
Parents smoke	115	94.4
Parents don't smoke	151	95.1
Weaned <6/12	167	95.3
Weaned >6/12	99	95.9
Hospital delivery	177	94.7
Home delivery	86	95
Indwelling fireplace	172	94.8
Separate fireplace	93	94.9
Up to date/complete vaccine	188	95.2
Unimmunized/incomplete	78	95

	n=266	Oxygen Saturation % Mean (95% CI)	SD
Asleep	35	92.7 (91,94)	3.8
Awake	231	95.1 (94.8,95.4)	2.4
Outside bilum	211	95.3 (94.9,95.6)	2.4
In bilum (awake/asleep)	55	92.9%(92,93.7)	3.1
Parents smokers	115	94.4 (93.1,94.5)	2.9
Parents non-smokers	149	95.1 (93.8,95.1)	2.7

- Infants who were asleep had lower SpO₂ than those who were awake **(92.7% vs 95.1%, p<0.0001)**
- Infants who were in bilums (whether awake or asleep) had lower SpO₂ than those who were awake **(92.9% vs 95.3%, p<0.0001)**
- Infants whose parents smoked had lower SpO₂ than those whose parents did not smoke **(95.1% vs 94.4%, p<0.055)**

DISCUSSION

- ▶ This research has confirmed that :
 - ✓ Oxygen saturations reduced as we go further above from sea level.
 - ✓ younger infants have a lower saturation than older children
 - ✓ children whose parents smoke have a lower saturation
 - ✓ Babies in bilums, whether awake or asleep, tend to have a lower O₂ saturation.
- ▶ The location of delivery, history of illness in the neonatal period, whether the parent reported a current cough, or whether the infant was formula fed or weaned early, and the type of home fireplace were not associated with lower O₂ saturation in this study sample.

POTENTIAL LIMITATION:

- Potential for bias or subjective assessment
- Parents might omit information when filling a questionnaire.



CONCLUSION

- ▶ This study provides a definition of normal SpO₂ in a healthy population of children under 5 years old living at high altitude.
- ▶ With the use of pulse oximetry, SpO₂ should be considered a fifth vital sign.
- ▶ We have also shown that younger children have a lower mean SpO₂ than older children living at high altitude, which suggests physiological adaptation to high altitude over time.
- ▶ Although sleep had a lowering effect on SpO₂, the clinical importance of this remains undetermined.
- ▶ Babies being carried around in bilums have an increased risk of hypoxia, that may have implications for high risk babies (e.g. preterm, young infants recovering from pneumonia, etc.)



FURTHER RESEARCH

- ▶ Further study into the oxygen saturation reference value for neonates, or the first 24 hours after birth.
- ▶ Awareness of the dangers of parents smoking, mothers should be careful if babies are being carried in bilums, especially if the infant is high-risk (e.g. preterm).
- ▶ A study to see if climate causes changes in O₂ saturation, as reduced temperature greatly influences the affinity of oxygen to be bound to Hb. So a study in the cold, mountainous parts of Enga Province.
- ▶ Further research on pulmonary hypertension and hypoxaemia: Among patients coming in with pneumonia, bronchiolitis or congenital heart disease, or heart failure due to pulmonary infection what are the factors that predisposes them to be admitted, re-admitted and having clinical features of heart failure.



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8. WHO Pulse Oximetry Training Manual 2011

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