Nocturnal hypoxia in high altitude native children – evidence of incomplete adaptation in children with mixed ancestry.

Catherine M Hill¹,², Ana Baya³, Johanna Gavlak²,⁴, Annette Carroll⁶, Kate Heathcote⁶, Dagmara Dimitriou⁷, Veline L’Esperance⁹, RJ Webster⁹, JW Holloway¹⁰, Javier Virues-Ortega¹¹, Fenella J Kirkham¹,²,⁴, Romola S. Bucks*¹² & Alexandra M. Hogan¹³,¹⁴ * (*Dr Bucks and Dr Hogan are joint Senior Authors)

1 Division of Clinical Experimental Sciences, Faculty of Medicine, University of Southampton, UK
2 Southampton Children’s Hospital, Southampton, UK.
3 Department of Psychology. Universidad Privada de Santa Cruz de la Sierra, Santa Cruz – Bolivia
4 Neurosciences Unit, University College London Institute of Child Health, UK
5 Sleep Disorders Unit, Canberra Hospital, Australia
6 Department of Otolaryngology, Poole General Hospital, UK
7 University College London, Institute of Education, UK
8 Department of Primary care and Population Health, Kings College London, UK
9 Laboratory for Cancer Medicine, Harry Perkins Institute of Medical Research and University of Western Australia Centre for Medical Research, Perth, Australia
10 Division of Human Development and Health. Faculty of Medicine, University of Southampton, UK
11 School of Psychology, Faculty of Science, The University of Auckland, New Zealand.
12 School of Psychology, University of Western Australia, Perth, Australia
13 Cognitive Neuroscience & Psychiatry, UCL Institute of Child Health; UK
14 Department of Anaesthetics, Whittington Hospital, London, UK

Objectives

We studied developmental aspects of sleep related breathing in high altitude, native children. Physiological adaptation to high altitude hypoxia may be impaired in Andeans with significant European ancestry. The respiratory ‘burden’ of sleep may challenge impaired adaptation leading to relative, nocturnal hypoxia. Nocturnal hypoxia in early development may have life-long implications.

Methods and materials

Diurnal and nocturnal oxyhaemoglobin saturation (SpO₂) was measured in 75 healthy Bolivian children aged 6 months to 17 years, native to low altitude (500m), moderate high altitude (2500m) and high altitude (3700m), 62 of whom had 5 hours of nocturnal artefact-free data. Genetic ancestry was determined from DNA samples.

Results

Children had mixed ancestry (average composition 41.6% European, 56.9% Native American, 1.5% African), with no significant altitude differences. As predicted, diurnal SpO₂ decreased across altitudes, with a significant age by altitude interaction, such that infants had the lowest diurnal values at high altitude. Novel findings include a significant effect of both age and altitude on sleep-related fall in mean nocturnal SpO₂ and SpO₂ stability. At high altitude there was a greater drop in nocturnal SpO₂ across all ages and an increase in SpO₂ variability, compared to low altitude. These differences diminished with age.
Conclusions

Physiological adaptation to HA living in native Andeans is unlikely to compensate for the significant differences we observed between diurnal and nocturnal SpO₂, most marked in infancy. This vulnerability to sleep-related hypoxia in early childhood has life-span implications. Future studies should characterise the nocturnal respiratory physiology underpinning our observations.

Figure: Developmental trajectory of diurnal and nocturnal SpO₂ values

Wake and sleep mean pulse oximetry at altitudes by age-group (infants, 6 – 12 months old; children, 4 – 10 years old; adolescents, 13 to 17 years old). Error bars are standard errors.