The Project	Project name	Heart rate variability at high altitude
	Project expedition	2003 Hongu expedition
	Aim of project	Exposure to high altitude causes physiological changes due to altitude hypoxia. For example, heart rate increases, but there are not only changes in your heart rate, but also changes in its variability, the heart rate variability (HRV). Looking in detail at this can give useful information about the relative balance between parasympathetic and sympathetic tone. (These are parts of the autonomic nervous system involved in the control of automatic processes in the body, like airway calibre in the lungs, heart rate and gut function). Another effect of altitude exposure is impaired sleep and also periodic breathing during sleep is common at high altitude. The first aim of this study was to investigate the effect of high altitude exposure on the activity of the autonomic nervous system. The second aim of the study was to investigate if a relationship exists between HRV and periodic breathing at high altitude. In addition, the effect of temazepam, which is known to promote a normal breathing pattern, on the occurrence of periodic breathing and HRV was examined.
	Project funders	
Project staff	Lead person	Mireille Baart, Paul Richards, Annabel Nickol, Mary Morrell, Mark Dayer
	Assistants	
	Institutes involved	This project was a MSc research project of Mireille Baart, at Wageningen University, the Netherlands.
Data collection	What you did to the subjects	Seven healthy male subjects were included in the study. Electrocardiogram (ECG) recordings were made during sleep at sea level on 1 night and after a 3 weeks trek to an altitude of 5000m on 2 consecutive nights. The arterial oxygen saturation (SaO_2) was measured to detect periodic breathing. The subjects were given temazepam or a placebo on different nights at 5000 m.
	What data you collected	ECG recordings
	What you did with the data afterwards	The ECG recordings were used for so called power spectral density (PSD) analysis of HRV. PSD analysis creates a power frequency spectrum which shows how power is distributed as a function of frequency within the ECG signal. Different frequency components of the power spectrum are associated with different autonomic activity, and so the relative balance between parasympathetic and sympathetic tone can be assessed.
Photos	Attach 2 photos of research in action!	
	Photo captions	Mireille Baart is taking ECG records from Doug Thake in basecamp for the Heart rate variability project
	Who took the photos?	(probably) Piotr Szawarski
The results	What did you find out? (positive & negative results)	In most subjects the sympathetic nervous activity was increased and the parasympathetic activity was decreased at high altitude compared to sea level. In general, the sympathetic nervous system stimulates the body during activity and the parasympathetic nervous system is more active during rest. The observed increased sympathetic tone at high altitude implies that even in rest the body is more active at high altitude to exert its physiological functions, which is probably the result of hypoxic stress. We found no effect of the use of temazepam on HRV at high altitude. Unfortunately, it was impossible to relate changes in HRV to periodic breathing.
	How has this helped high altitude research?	Unfortunately, we were not able to collect enough data to draw reliable conclusions.
	How has this helped sea level medicine?	Not directly, but it could be possible that the same changes in autonomic nervous activity occur at sea level in situations of hypoxia, e.g. in case of impaired lung function.
Sharing the results	What papers have been published	-
	What conferences have been attended	-
	What books include	-

	information	
The future	What plans do you have to use the data in the future	-
	What do you think should be researched next?	First of all, the study should be repeated in a larger study population and a possible relationship between HRV and periodic breathing at high altitude should be examined. If the same results will be obtained in a larger population, it would be interesting to investigate if the pathological changes that occur at high altitude (in AMS, HAPE or HACE for example) are associated with a change in autonomic nervous activity and whether these pathological changes could be prevented by drugs that influence the activity of the autonomic nervous system.
	Any other comments / advice for others?	