terraXcube
eurac research

Large Cube

Students Training Camp to evaluate the reduction of the plasma volume at high altitude

The test in a nutshell

Atmosphere

Group testing

terraXcube

terraXcube is Eurac Research's extreme climate simulation centre at the NOI Techpark in Bolzano, South Tyrol, Italy. Within its chambers, even the most extreme of all our Planet's environmental conditions can be created. By combining hypobaric and altitude technology with state-of-the-art environmental simulation, we aim to investigate the effects of extreme climate conditions on humans, ecological processes and industrial products.
The climate chambers differ in size and equipment and can accommodate people, plants and other living organisms for up to extended periods and have the space to accommodate large machines and products.
Each day our team breaks new ground with scientists and industry partners and prepares the path to gain discoveries.

Test description

The cardinal challenge that humans face at high altitude (HA) is reduced oxygen availability (hypoxia). Acute exposure to hypoxia facilitates a decrease in arterial O2 content (CaO2) that impairs both physical and cognitive performance. However, if hypoxic exposure extends over days, a reduction in plasma volume (PV) increases arterial haemoglobin concentration and thus normalises CaO2. Studies investigating the mechanism(s) underlying this reduction in PV have reported controversial findings. A potential explanation is that these studies were mostly conducted in HA research stations, where subjects were exposed to fundamental changes in diet, water consumption, physical activity, sleeping behaviour and temperature. Since all these changes can affect PV, it was difficult to isolate the effect of hypoxia. Furthermore, logistic constraints at HA often prevented the use of sophisticated measurement techniques.

In this study, it was possible to avoid these limitations by using the terraXcube, which allowed minute control of experimental conditions. In a crossover design, 11 healthy lowlanders completed two 4.5-day sojourns in the terraXcube, with barometric pressure corresponding to the level of Bolzano during one sojourn and to the equivalent of 3,500 m during the other (representing HA). All other environmental variables as well as, diet, water consumption, physical activity and time in bed were closely matched between the two sojourns.
To evaluate the mechanisms reducing PV at HA, we performed daily blood sampling and measurement of (anti)diuretic hormones as well as circulating concentrations of electrolytes and proteins. Similarly, 24 h urine was collected and analysed throughout the sojourns. Total body water, plasma volume as well as intracellular fluid shifts were measured by gold standard techniques.

Main focus

Determining the physiological mechanisms underlying the reduction in plasma volume that occurs with high altitude acclimatisation.

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Large Cube - General Characteristics and Environment Control

Internal dimensions	12 m x 6 m x 5 m (L x W x H)
Useful Square Footage	137 m² + 100 m² for test setup
Access to the chamber	Large sliding door: 3.6 m x 4 m (W x H)
Maximum simulated altitude	9,000 m ±10 m (~ 30,000 ft)
Maximum Rate of Climb (ROC)	6 m/s (~ 1,180 ft/min); 14 m/s (~ 2,756 ft/min) in the airlock
Minimum Rate of Climb (ROC)	0.1 m/s (~ 20 ft/min)
Temperature Range According to IEC 60068-3-5	-40...+60°C (± 1°C in time ± 2°C in space)
Temperature Rate of Change According to IEC 60068-3-5	± 0.5°C/min (cooling & heating)
Relative Humidity T > 4°C and according to IEC 60068-3-6	10...95% ± 3%
Humidity Rate of Change T > 4°C and according to IEC 60068-3-6	0.4%/ min cooling; 0.5%/ min heating
Wind	Up to 30 m/s
Precipitations	Rain: 0...60 ±1 mm/h Snow: up to 50 mm/h
Capacity	Up to 12 participants and 3 investigators
Duration of the Study	Up to 45 days without interruption
Medical Monitoring System	Full medical monitoring system for both test subjects and investigators: • Portable harness • Wireless data transmission within the chamber • Real time medical data acquisition – ECG – SpO2 – Blood pressure – Core temperature • Synchronised medical and environmental parameters • Threshold alarms
Available Equipment	Climbing wall Audio & video projection system Treadmills and cycle ergometers Individual sleeping stations Gaming console Doppler ultrasound

Ambulatory Room

General Characteristics	The ambulatory room allows participants to be medically examined during tests. It can also be used to evaluate small or medium-sized objects at high altitudes and non- extreme temperatures. The room has a line of sight between the control room on one side and the test chamber on the other via pressure-tight windows.
Internal dimensions	4.5 m x 2.8 (L x W)
Maximum simulated altitude	9,000 m ±10 m (~ 30,000 ft)
Maximum Rate of Climb (ROC)	6 m/s (~ 1,180 ft/min)
Minimum Rate of Climb (ROC)	0.1 m/s (~ 20 ft/min)
Temperature Range	20...30°C ± 1°C

Additional facilities/rooms

Airlock with Toilet & Shower	For altitude usage max 9,000 m ±10 m (~ 30,000 ft)
Ambulatory at ground level (ca.270 m)	For preliminary examination, anamnesis and test at ground level
Laboratory for exams and sample preparation	Blood gas analysis, blood viscosity
Changing Rooms (f/m)	

Other Features

Power Supply	230Vac 1~ 50Hz, 400Vac 3~ 50Hz, 63A
Data-acquisition equipment Smoke/Fire detection system + Fire suppression system CC cameras	
Network connection	Gigabit-Ethernet (1000BaseT) PoE, Wi-Fi
Oxygen	