



## ***Physiological and Psychological alterations over a sojourn in Antarctica***

- 1.1 Project Title** *Physiological and Psychological alterations over a sojourn in Antarctica*
- 1.2 Project Officer** *Mr. Philip Avery*
- 1.3 Associated Workers** *Prof Mike Tipton, Alun Rees, Dr Tara Reilly, Dr Frank Golden, Dr Neil Weston, Dr Clare Hencken, Phil Newton, Julia Allen, Amanda Ward, Christine Balch.*
- 1.4 External Consultants** *Dr. Mike Stroud*
- 1.5 Independent Medical Officer** *Dr Dan Roiz de Sa*
- 1.6 Tasking Reference** *Fuchs Foundation MOU*
- 1.7 Establishments** *Fuchs Foundation & University of Portsmouth*
- 1.8 Location for Study** *Spinnaker Building, University of Portsmouth; Fieldwork: Ellsworth Mountains of Antarctica*
- 1.9 Experimental Dates** *29<sup>th</sup>-30<sup>th</sup> May 2007, October-December 2007*

## **2. INTRODUCTION**

In November 2007 four teachers and two guides went to the Ellsworth Mountains of Antarctica. They spent five weeks camping on the ice and conducting research. The expedition was organized by the Fuchs Foundation ([www.fuchsfoundation.org](http://www.fuchsfoundation.org)); founded in honour of Sir Vivian Fuchs, an Antarctic Scientist, first Director of the British Antarctic Survey and the first person to successfully traverse the continent in 1957/58. The Fuchs Foundation see the research as a means to creating teaching materials that will inspire students about Geography, Science and Education.

Six people camping at 80° South who are focused on research rather than getting to the Pole, was also an opportunity to further the understanding of how humans cope physiologically and psychologically with adverse conditions, specifically extreme cold. This in turn can help prepare people to go into low temperature regions and other adverse environments. It was with this in mind that The Fuchs Foundation and the Human & Applied Laboratory of the University of Portsmouth became partners.



Dr. Mike Stroud, from the University of Southampton, breaks human ability to cope with cold down into three areas ('Survival of the Fittest', Dr. M. Stroud, 2004, Yellow Jersey Press; Personal meeting with Dr. M. Stroud, 15/08/06):

- Increased heat production
- Decreased heat losses
- Changes to the bodies periphery (e.g. hands, feet and face)
- In addition anthropometric alterations were expected, and in addition different psychological approaches to coping with the adverse environment represented by Antarctica.

This study investigated the impact of a period in Antarctica on these variables

As the Fuchs Foundation plan to send parties to Polar Regions about every two years it was likely that this study could become part of a continuing investigation.

This work has been requested by the Fuchs Foundation. The Project Officer and associated workers had no conflicts of interests.

### **3. AIM[S]**

To determine the physiological and psychological alterations associated with time spent in Antarctica.

### **4. HYPOTHESIS**

4.1 An expedition to Antarctica will result in significant alterations in the physiological and psychological variables tested.

### **5. METHODS**

#### **5.1 Design, Sample Size and Early Stopping Rule**

5.1.1 The study had a within subject repeat measured design; this is the best design for small number pre and post testing.



5.1.2 All six participants of the Fuchs Foundation 2007 Antarctic Expedition undertook all of the tests outlined below.

5.1.3 Preliminary statistical analysis was performed after the six subjects completed the trial. It was intended that if the results achieved a level of statistical significance of  $P < 0.05$  or better, then the trial would be terminated and final analysis would be complete at that stage.

5.2 **Subjects** The subjects have been recruited by The Fuchs Foundation. Subjects were male and female, between the ages of 18-40, fit and healthy, proficient swimmers, and had no history of cold induced illness or heat illness or intolerance. Written informed consent was obtained from each subject and kept on file.

5.3 **Exclusion Criteria** The IMO performed medical examinations and excluded subjects in accordance with the Procedures for the IMO, EMU.<sup>2</sup> Subjects were also excluded on any of the following grounds:

Cold Injury

Heat Illness

Chronic Cardiovascular or Respiratory Disease

#### 5.4 **Procedures & Measures**

5.4.1 The volunteer participants visited the laboratory before, shortly before and immediately after their sojourn to Antarctica. They all undertook the following tests on each occasion:

##### 5.4.2

**Anthropometry:** Dr Clare Hencken. A Full anthropometrical profile consisting of 39 measurements was be completed on each participant. These were in accordance with ISAK accredited methods and procedures and consisted of 8 skin folds, 13 girths, 9 lengths and 6 breadths in addition to 3 basic measurements. Subsequent indirect measurements such as sitting height to stature ratio were calculated thereafter. All measurements were taken twice to minimise error and TEMS were computed specific to the population.



**Cold Injury:** Dr Frank Golden. The subjects spent 30 minutes seated at rest in air at 30°C wearing normal clothing but with their shoes and socks off. During this period they were instrumented with a laser Doppler probe on the great toe pad of each foot and skin thermistors on the chest, great and small toe, middle of the plantar surface of the foot and heel. Once instrumented the subjects were laid on a couch for 5 minutes whilst baseline data were collected, they then placed their left foot into a plastic bag and lower it into water at 15°C for 2 minutes. At the end of this period the foot was removed from the bath and bag and allowed to spontaneously rewarm for 10 minutes. Peripheral blood flow was recorded continuously throughout; skin temperature was recorded at 30 second intervals

**Thermal Sensitivity:** Dr Tara Reilly. Thermal sensitivity was evaluated with the Physitemp Thermal testers (PTT) NTE-2 and NTE-2A, which consists of a single wand type probe (thermode) 4.08cm<sup>2</sup> (13mm diameter). Thermal electric cooling or heating was achieved by the PTT using the Peltier effect and water profusion. The devices were sensitive to 0.35-1°C and could be adjusted at a rate exceeding 1°C per/sec. The NTE 2 has accuracy to 0.35-1°C and a range of 0°C to 50°C. Subjects were also given a familiarisation trial to become familiar with the expected thermal sensations. The probe was in contact with the forearm and the temperature was increased or decreased (random order) at a rate of 0.35-1°C/sec, until such time that the subject indicated if they perceive a warm or cool sensation. Fingers (non-dominant) and face were assessed for thermal sensitivity thresholds. Subjects were required to refrain from using cosmetics and alcohol based solutions on the head during the 12h prior to their test (Essick et al, 2004). Prior to experimentation the site was cleansed twice with a solution of glycerine and water (Essick et al, 2004). Subjects were required to sit relaxed in 21°C temperature room for 30 minutes; skin thermistors recorded skin temperature. It was important that subject skin temperature be uniform before testing (Stevens, 1979). Skin on the face and hands were dried with a sterile towel.

The probe was applied perpendicularly to the test site with consistent and comfortable pressure starting at a temperature matching the skin at that site. The temperature of the probe was increased or decreased at a rate of 0.35-1°C/sec until the subject indicated a correct verbal acknowledgement that the stimulus is warmer or colder. Studies on thermal sensitivity, delivering a



thermal stimulus have employed a range from 0°C-50°C (Becser et al, 1998; Essick et al, 2004) at a rate of 1°C/sec<sup>-1</sup> (Golja, 2004; Becser et al,1998) based on available neuro-physiological evidence. Essick et al (2004) used a rate of 0.35°C/s.

Subjects with broken skin at test sites, emphysema, peripheral vascular disease, diabetes mellitus, systemic, psychological or emotional disorders, or significant occupational exposure to neurotoxic substances, were to be excluded (Essick et al., 2004).

**Anaerobic & Aerobic fitness:** Alun Rees, Amanda Ward, Christine Balch. Subjects were first asked to perform an isometric strength test of the forearm using a grip dynamometer (Takei-D). Results are provided in kg/F. Subjects were then asked to participate in a 30 second anaerobic Wingate test (WAnT) and after a period of rest of at least 1 hour asked to perform a maximal aerobic test (VO<sub>2</sub> max).

For the WAnT, subjects used a cycle ergometer (Monark 874E). They cycled at a resistance loading equivalent to 7.5% of their body mass at maximal effort for 30 seconds following a standardised warm up. The Wingate software (Cranlea) measured peak power (W), mean power (W) and rate of fatigue (%).

The VO<sub>2</sub> max test was undertaken using a continuous incremental protocol. A resting blood lactate measurement was taken. The subject performed the test on a cycle ergometer (Monark 874E) until volitional exhaustion. During the test, expired gases and gas volume were continuously measured using an on-line metabolic system (Jaeger Oxycon Delta). Heart rate was also continuously monitored following attachment of a heart rate monitor (Polar) to the chest. A sample of capillary blood was collected 5 minutes post-exercise and analysed for blood lactate concentration. The assessment of VO<sub>2</sub> max was determined against BASES reference criteria.

At all times, the testing complied with BASES guidelines for the physiological testing of athletes (BASES 2006).



**Null zone assessment:** Prof Mike Tipton & Phil Newton. Each volunteer changed into a swimming costume (female's two-piece) and was instrumented (see below). They then entered a climatic chamber at 10°C, 50% RH. They cycled on a bicycle ergometer at 50%  $VO_{2max}$  (established during aerobic testing) until they begin to sweat, at this time they stopped exercising until they cooled to the point where they started to shiver, they then exercised again until they begin to sweat. Sweating and shivering onset and offset was measured, as will the threshold for vasoconstriction and vasodilatation.

### Measures

- Deep body temperature: using a thermistor was inserted in the ear close to the tympanum (Tau, EAR-U-VLS-0, Grant Instruments, UK) and into the rectum, 15cm beyond the anal sphincter (Tre, REC-U-VL-2, Grant Instruments, UK).
- Skin Temperature (Tsk): was measured at 4 sites (chest; arm; thigh; calf; and back) using surface thermistors (EUS-U-V52-2, Grant Instruments, UK) attached with single pieces of tape.
- Heat Flux (H): was measured at the same sites as temperature using surface sensors (Concept Engineering, USA) attached with single pieces of tape.
- Tre, Tsk and H data were recorded every minute onto a data logger (Squirrel data logger, Grants Instruments, UK).
- Peripheral blood flow on the middle finger of the non-dominant hand and great toe pad of the non-dominant foot: using Laser Doppler surface probes were attached by a single piece of tape.
- Shivering onset and offset/metabolic rate (mean body temperature thresholds): using breath by breath oxygen analysis exhaled gas collected via a mouthpiece and tubing analysed for volume,  $O_2$  and  $CO_2$  concentration.
- Sweating onset and offset (mean body temperature thresholds): using a sweat capsule attached to the forehead.
- Subjective responses: using computer-based thermal comfort and thermal sensitivity scale.



Mean skin temperature was calculated according to the formula:

Mean Tsk = 0.3 (Tchest + Tarm) + 0.2 (Tthigh + Tcalf) (Ramanathan, 1964)

Mean body temperature was calculated according to the formula:

Mean Body temperature (Tb) = 0.8Tre + 0.2Tsk (Colin et al, 1971)

The average specific heat of body tissues was assumed to be 3.48kJ.kg<sup>-1</sup>°C<sup>-1</sup> (Pembrey, 1898).

**Exercise log:** Phil Avery.

Whilst in Antarctica subjects kept a log of exercise intensity and duration.

**Psychological Assessment:** Dr Neil Weston. Subjects completed a short bipolar questionnaire (see example questions in Annex C) each day to examine changes in the psychological state throughout the expedition. Questions examined a range of bipolar cognitive responses including happiness/depression, not at all lonely/lonely, mental alertness/fatigue, physically 100%/fatigued, motivated/lack of motivation, calm/stressed, comfortable/uncomfortable, feel happy in my accomplishments / feel unhappy in my accomplishments, getting on well with fellow expedition colleagues/ not getting on well with fellow expedition colleagues. These responses were correlated with the amount of sleep, hours spent dealing with problems, hours spent physically active and number of hours experiencing a cold related illness.

**5.4.3 Withdrawal Criteria** Subjects stopped any of the tests on attaining the first of the following criteria:

- a. on the request of the subject
- b. on the instruction of the local independent person
- c. on the decision of the Project Officer or deputy
- d. when rectal temperature exceeds 39°C or falls below 35°C
- e. when skin temperature falls below 8°C for 20 minutes.

## **5.6 Data Analysis**

5.6.1 The data was analysed using a repeated measures ANOVA to identify differences in any of the variables pre and post the expedition to Antarctica.



5.7 **Reporting** The work will be published as a University of Portsmouth report and open literature scientific paper if the data warrant it. Subject anonymity and confidentiality will be maintained.

## 6. **MEDICAL AND ETHICAL CONSIDERATIONS**

6.1 An Independent Medical Officer (IMO) assessed the subjects on arrival at the lab. A suitably qualified (determined by the IMO) first aider will be present during the testing.

6.2 This study complied at all times with the Declaration of Helsinki, as adopted at the 52<sup>nd</sup> WMA General Assembly, Edinburgh, October 2000.

## 7. **HAZARDS TO SUBJECT SAFETY**

7.1 **Electrical safety** All electrical equipment was checked for safety by suitably qualified technical staff prior to the trial start. Circuit breakers were used for all mains powered equipment to prevent accidental electrocution. All monitoring and other electrical equipment connected to subjects complied with appropriate human use standards regarding isolation and subject safety.

7.2 **Adverse Effects** These may include:

- Fatigue
- Cold pain

7.3 **Risk Assessment** Assessment of the risks for the above effects led to the conclusion that the risks are **LOW** given the medical monitoring and safety precautions in place.

## 8. **SUBJECT PAYMENTS**

8.1 The subjects did not receive a gratuity.





## 9. REFERENCES

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