

Interdisciplinary South Pole Innovation & Research Expedition  
**INSPIRE 22– Preliminary report to the Mount Everest Foundation**  
Prof Chris Imray

**Background:**

***Did Antarctic explorers starve to death?***  
***Laura Spinney: New Scientist 23<sup>rd</sup> September 1995***

*CAPTAIN Robert Scott and the members of his ill-fated expedition to the South Pole in 1912 are generally thought to have died of vitamin deficiency. But dietary data collected by the explorers Mike Stroud and Ranulph Fiennes during a trek across the South Pole suggest that Scott and his companions actually died of starvation, the BA heard last week.*

*Stroud described how he and Fiennes set out in November 1992 to cross Antarctica on foot in temperatures as low as  $-50^{\circ}\text{C}$ . Each pulled a sledge carrying enough food to provide them with 5500 calories a day – more than twice the intake of a normal adult – for 100 days. But Stroud, of the Defence Research Agency’s Centre for Human Sciences in Farnborough, anticipated that even with this high intake they would still lose weight, probably up to 10 kilograms each. In fact, Fiennes lost 25 kilograms and Stroud lost 22 kilograms. When their energy expenditure reached its maximum each man was burning up about 11 000 calories per day. “Our [energy] deficit was more than running a marathon a day and not eating,” said Stroud.*

*Comparing his data from blood and urine analyses with data from the 1912 expedition, Stroud suggested that Scott’s daily energy intake of 4300 calories was nowhere near enough. Scott and his companions would have lost between 30 and 40 kilograms during the expedition, said Stroud, and they probably starved to death. Moreover, Stroud and Fiennes’s diet contained 57 per cent fat, which provides more calories per gram than any other food, minimising the burden they had to drag. Scott’s rations contained a much higher proportion of protein, so they had to carry more to provide a given amount of energy.*

*Stroud said that although his data are limited – with only two of them on the journey – the figures he gathered on energy intake, output and balance are unusually accurate. The rations were fixed and there was time to make detailed measurements of work output.*

In 2016, the Mount Everest Foundation generously supported setting up a metabolic research registry-GPAMrr- based in Human Metabolic Research Unit at University Hospitals Coventry and Warwickshire NHS Trust to assess the metabolic cost of extended polar and high-altitude travel. (<https://www.rgs.org/in-the-field/advice-training/resources-for-expeditions/global-polar-altitude-metabolic-research-registr/>)

To date GPAMrr has included 2 expeditions to Antarctica (SPEAR17 and Ice Maidens: both Antarctic crossings) and one expedition to the Himalayas- Broad Peak (8,051m).

Both Antarctic expeditions found significant weight loss amongst participants. In SPEARS 17, an all-male team, we found in addition to weight loss there appeared to be both a reduction in fat

and muscle composition; whilst in the Ice Maiden team there was a less marked weight loss with a reduction in fat but a modest increase in muscle composition. The GPAMS bibliography can be found at end of this paper.

### Study Aims

The INSIPRE-22 were three-fold:

1. To assess in more detail the metabolic tariff of prolonged polar travel. In particular simultaneously comparing men and women on the same expedition prospectively. In addition to pre-departures studies in the UK, additional studies in Chile and on ice studies were included so addressing previous reviewer’s concerns.
2. To assess 5 different wearable technologies for on-ice physiological measurements.
3. To assess the psychological challenges of prolonged polar travel

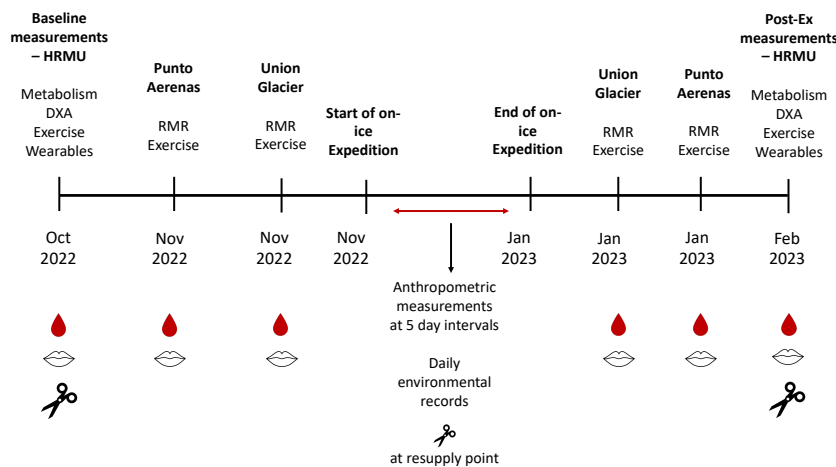
### Finances

Multiple funding streams were used including philanthropists, Ministry of Defence research budgets, National Institute for Health Research, University Hospitals Coventry and Warwickshire NHS Trust, Coventry University and the charitable trusts Mount Everest Foundation, Gino Watkins Memorial Fund, JABBS Charitable Trust and the Andrew Croft Memorial Fund.

All funding streams were in place a few weeks prior to departure.

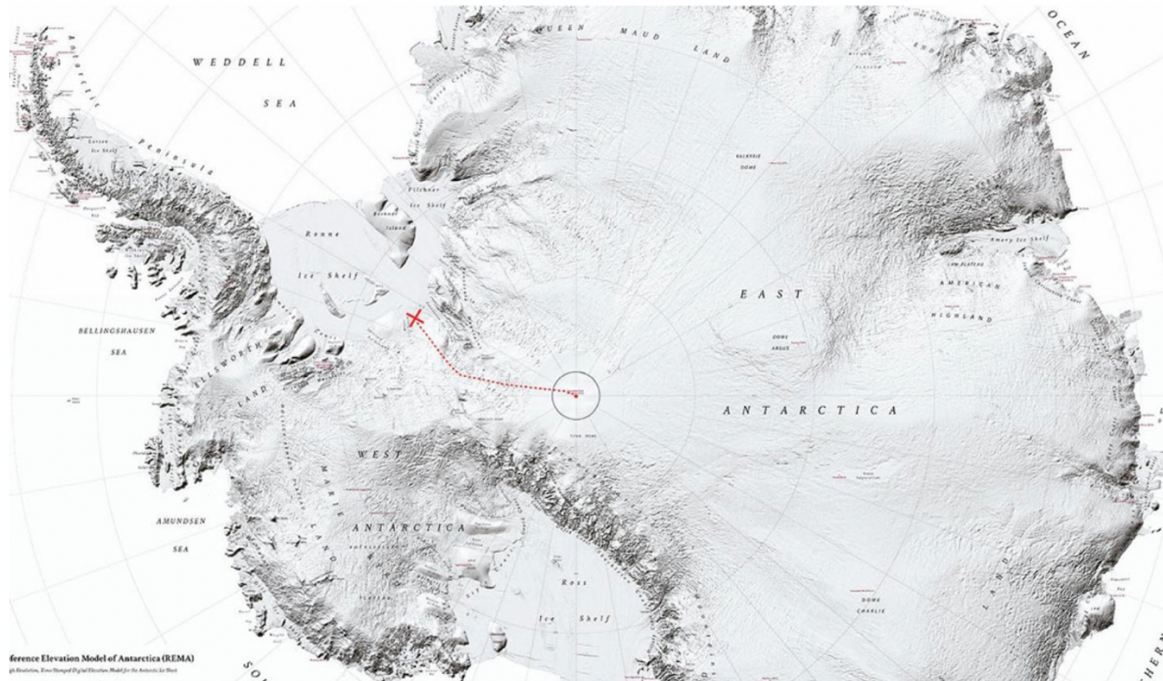
The Mount Everest Foundation monies were put towards designing and producing a novel 3D printed metabolic measurement system that was used both in the UK and on ice. We are extremely grateful to the MEF for supporting the expedition and without their support we would have struggled to have funded this key aspect of the expedition.

### Expedition research timeline



**Figure 1.** Overview of Study timeline. Blood, saliva, hair. Expedition timeline/summary/preliminary results

Expedition members had a preliminary 10-day expedition to Norway in March 2022. There were also several training weekends in Wales, England and Scotland. Baseline experiments took place in Coventry at University Hospitals Coventry and Warwickshire NHS Trust and Coventry University in October 2022. The team of nine (3 women) left the UK on 7<sup>th</sup> November, completed the Punta Arenas testing and final preparations over the next 10 days flying to Union Glacier on 21<sup>st</sup> November 2022. We were dropped by DC3 plane on the 'sea' ice at 100m above sea level at the start of the 950 km Messner Route on 24<sup>th</sup> November 2022.



From the "Messner Start" on the edge of the Ronne ice shelf, it is more than 900 kilometers to the South Pole. Map: via Twitter @Go\_Inspire\_22

<https://polarjournal.ch/en/2022/12/05/what-do-polar-expeditions-mean-for-the-human-metabolism/>  
<https://www.inspire22.co.uk>

We skied to the South Pole (2835m) over the next 47 days averaging 12 nautical miles/day or 23km/day.

We had two rest days.

On ice experiments took place every 5 days.

We consumed approximately 5,500 calories per day and have collected individual participant datasets for all food consumed.

There were four vegetarians in the group.

We remained on freeze dried food for 48 hours after reaching the South Pole, this was until on-ice metabolic measurements were completed.

All nine participants and two guides (non-research participants) completed the expedition without significant adverse events.

All participants lost weight. The weight loss was mainly in the fat compartment and subjects appeared to put on muscle. Men appeared to lose more absolute weight and had a greater percentage weight loss.

We plan to complete the analysis of the data set over the next 6 months and intent to submit for publication in appropriate peer review journals.



**Team at Heathrow prior to departure**



**Metabolic assessments in Punta Arenas, Chile**



**Team at the South Pole 9<sup>th</sup> January 2023**

**GPAM registry bibliography to date:**

1. Hattersley J, Wilson AJ, Gifford R, Facer-Childs J, Stoten O, Cobb R, Thake CD, Reynolds RM, Woods D, Imray C. A comparison of the metabolic effects of sustained strenuous activity in polar environments on men and women. *Sci Rep.* 2020 Aug 17;10(1):13912. doi: 10.1038/s41598-020-70296-4. PMID: 32807833; PMCID: PMC7431584.
2. Gifford RM, O'Leary T, Cobb R, Blackadder-Weinstein J, Double R, Wardle SL, Anderson RA, Thake CD, Hattersley J, Imray CHE, Wilson A, Greeves JP, Reynolds RM, Woods DR. Female Reproductive, Adrenal, and Metabolic Changes during an Antarctic Traverse. *Med Sci Sports Exerc.* 2019 Mar;51(3):556-567. doi: 10.1249/MSS.0000000000001803. PMID: 30308528.
3. Hattersley J, Wilson AJ, Thake CD, Facer-Childs J, Stoten O, Imray C. Metabolic rate and substrate utilisation resilience in men undertaking polar expeditionary travel. *PLoS One.* 2019 Aug 15;14(8):e0221176. doi: 10.1371/journal.pone.0221176. PMID: 31415661; PMCID: PMC6695185.
4. Taylor N, Gifford RM, Cobb R, Wardle SL, Jones S, Blackadder-Weinstein J, Hattersley J, Wilson A, Imray C, Greeves JP, Reynolds R, Woods DR. Experience from the selection and nutritional preparation for Expedition ICE MAIDEN: the first successful all-female

unassisted Antarctic traverse. *BMJ Mil Health*. 2021 Feb;167(1):27-32. doi: 10.1136/jramc-2019-001175. Epub 2019 May 15. PMID: 31097481.

5. Hattersley J, Wilson AJ, Gifford RM, Cobb R, Thake CD, Reynolds RM, Woods DR, Imray CHE. Pre- to postexpedition changes in the energy usage of women undertaking sustained expeditionary polar travel. *J Appl Physiol* (1985). 2019 Mar 1;126(3):681-690. doi: 10.1152/jappphysiol.00792.2018. Epub 2018 Dec 20. PMID: 30571278.