Elevated resting metabolic rates among female, but not male, reindeer herders from subarctic Finland

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Resting Metabolic Rates in the Cold

Resting metabolic rate (RMR) is the minimum number of calories the body burns to survive and does not include other costs such as physical activity.

To study RMR, researchers measure people's RMR and

Resting metabolic rate increases in response to extended cold exposure.

compare those measurements to RMR predictions calculated from equations typical based age, sex, body weight and height.

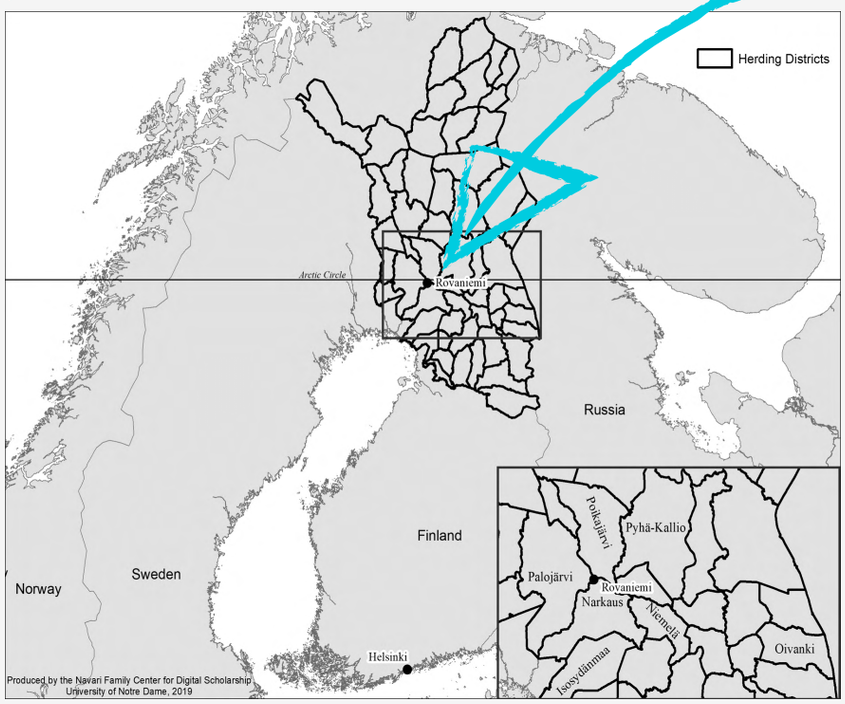
Several studies have demonstrated that cold climate populations have higher than expected RMRs. It is thought this helps maintain body temperature despite low environmental temperatures. However, there is lots of unexplained variation.

We measured RMR among reindeer herders in subarctic Finland to see if they had high RMRs like other cold climate populations.

Ocobock ice fishing in Kuttura

Measuring RMR among Herders in Finland

Where We Were



We worked with 5 women and 15 men who lived and worked near Rovaniemi, Finland in January 2019.

We took measurements at the Arctic Centre in Rovaniemi (pictured below), at the herders' homes, or in nearby hotels.

Who are the Herders?

Reindeer herders take part in subsistence and market economies, and the reindeer they herd are used for their own consumption and for trading or selling.

Daily activities differ seasonally, but they are physically demanding and require exposure to the extremely cold environment.

Herders' work includes herding to protect reindeer from predators, searching for the remains of reindeer lost to predators, repair of fences, driving reindeer away from populated areas, feeding reindeer, slaughtering reindeer, ear marking new calves, planning meetings, and bookkeeping.

A scene from the herd round-up, which takes place in late fall.

Measuring RMR

Ocobock measuring RMR from a herder (lying down). The mask is connected to an indirect calorimeter.

To measure RMR, the person has to have not eaten any food or consumed caffeine or alcohol for at least 12 hours before the measurement.

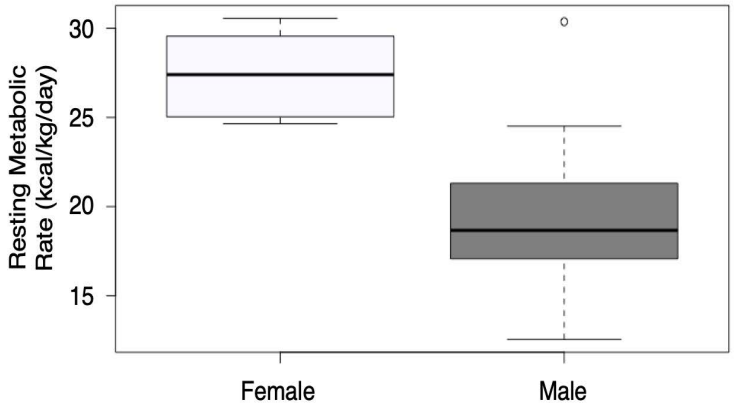
We use indirect calorimetry to measure RMR. The person wears a mask (see picture to the left) that measures how much oxygen they breathe in and how much carbon dioxide they breathe out.

The amounts of oxygen and carbon dioxide are used to calculate how many calories a person burns at rest. We then compare the measured RMRs to predictions from equations .

What We Found

Women had High RMRs

Men typically have higher RMRs than women. That is because men are larger, and RMR is



Women burned more calories at rest than men in this study

closely related to body size. When you control for size, the RMR differences between men and women disappear.

Female herders in this study had higher RMRs (even when accounting for differences in body size) than men.

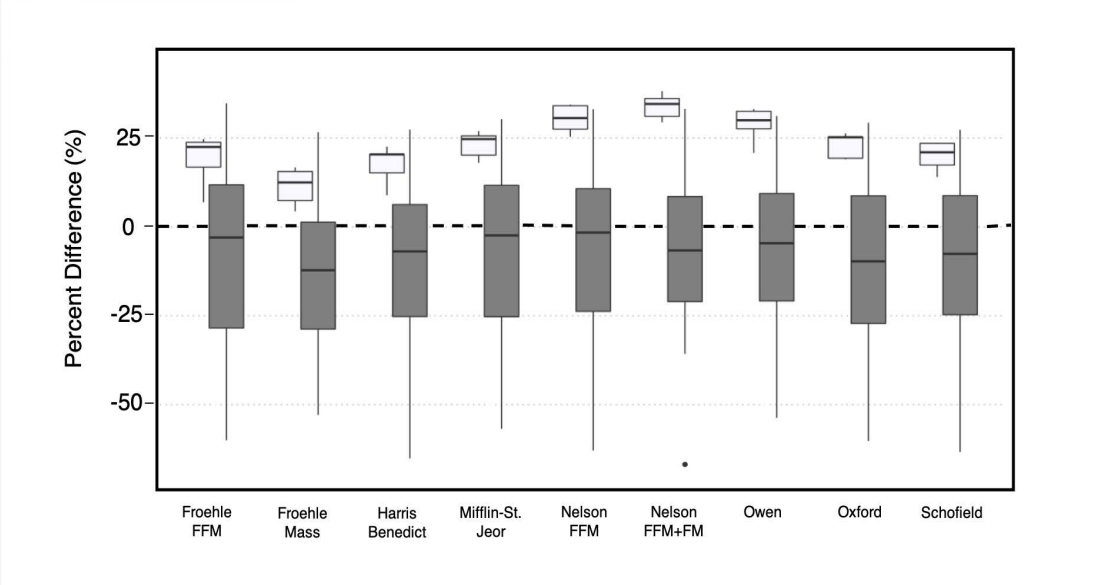
This has never been seen before.

Men had lots of RMR Variation

We compared RMR measurements to predictions from equations.

Women (white bars) had RMRs significantly & consistently higher than predictions (dotted line).

Men (gray bars) had RMRs that were not significantly different from predictions. This is because men exhibited a lot of variation - RMR measurements were higher and lower than predictions (dotted line)



Each pair of white and gray bars represents the percent difference from RMR predications calculated from equations.

What Does All This Mean?

We measured resting metabolic rate among female and male reindeer herders in order to examine how many extra calories they burn because they live in a cold climate. Here's what we found and what it might mean.

Predictive equations aren't perfect

A variety of predictive equations failed to accurately represent measured RMR - especially among women.

Lots of RMR variation among men

RMRs among men ranged from much higher to much lower than expected. This might be due using technologies that help keep people warm, reducing the need to maintain a high RMR to maintain body temperature.

Women had high RMRs

Women had RMRs higher than expected and higher than men. They also did not show the wide range of variation that men did.

RMR among women may be constrained

RMR is associated with thyroid hormone. We think higher thyroid hormone levels may increase RMR.

Thyroid hormone is also critically important for a successful pregnancy.

Female herders, even if they use technology to stay warm, may have to maintain higher thyroid hormone levels (and thereby higher RMR) because of the role thyroid hormone plays in pregnancy.

Climate change may play a role

The Arctic has experienced the effects of climate change earlier and more acutely than the rest of the world. Higher RMR variability may be indicative of warmer environmental temperatures.

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