

Changes in body tissue composition during the Transeuropean Footrace 2009 assessed by whole-body MRI in 12 Finishers

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Introduction

The Trans-European-Footrace 2009 (TEFR09) took place from April 19th to June 21st and went from Bari to the North Cape. Sixty-nine endurance athletes participated in this race with a total distance of approx. 4500 km in 64 stages (mean of 70km/day) without any day of rest. The race was accompanied by a mobile MR-unit (1.5 T Magnetom Avanto, Siemens Healthcare, Germany) and different examination protocols were conducted on various cohorts of participants. Aim of one examination protocol was quantification of adipose tissue and muscle mass and analysis of the follow-up data.

Material and Methods

Twenty-two runners participated in this study and underwent whole-body MRI for quantification of body composition. Twelve of these runners (11 males, 1 female, mean age 45.6 years) arrived at the North Cape and were included in this analysis. All of them underwent 6 MR-examinations: 1. before the race, 2. after about 650 km, 3. after about 1440 km, 4. after about 2630 km, 5. after about 3350 km, and 6. after about 4170 km. For determination of total body tissue composition and distribution, a TSE sequence was applied (TE/TR=12ms/490ms, slice thickness 10mm, 10 mm gap between the slices) [1]. A total of 100-130 images were obtained from fingers to toes from each volunteer. Post-processing was performed by an automated procedure as described in [2]. Following parameters were assessed: Total adipose tissue (TAT), visceral adipose tissue (VAT) and subcutaneous abdominal adipose tissue (SCAT_{abd}), adipose tissue of the lower extremities (AT_{LE}) ranging from feet to head of femur, adipose tissue of upper extremities (AT_{UE}) ranging from head of humerus to fingers, muscle mass of lower legs (MM_{LE}) and muscle mass of upper extremities (MM_{UE}). Additionally, yellow bone marrow, intestinal and gastric tissues were manually extracted from the data, as these compartments would influence the results. Head was extracted for analysis of MM_{UE}.

Results

Finishers arrived with a mean runtime of 525 hours (first: 430 hours, last: 696 hours). Prior to the race, they had a mean percent body fat of 17% and a mean VAT of 1.35 l (i.e. 2.3% of body mass). VAT showed the strongest reduction and was metabolized by 70% compared to the initial value. AT_{LE} and AT_{UE} were reduced by 50% and 65% and SCAT_{abd} by 37%. MM_{LE} was catabolised by 5% whereas MM_{UE} remained unchanged. Yellow bone marrow amounted to 15% of TAT prior to the race and 25% of TAT after the last examination. This highlights the importance of extracting this fat compartment in this cohort of slim endurance athletes. Figure 1 shows whole body profiles of a 28-year-old male runner: (a) initial profile, (b) after extraction of intestinal tissue, (c) after extraction of the head, (d) after extraction of yellow bone marrow. Temporal changes of the adipose tissue compartments from examination 1 to examination 6 are shown in Figure 2. It can be seen that VAT shows a nearly exponential decrease with a reduction of already 60% after 1440 km (third examination).

Discussion

In the framework of this extraordinary study, unique longitudinal data regarding different body tissue compartments (adipose tissue and muscle mass) were generated. Total adipose tissue was reduced by 50% with yellow bone marrow contributing to 25% of TAT. Different amounts of intestinal and gastric tissue after each stage and the considerable amount of yellow bone marrow show the importance of careful manual post-processing of the automatically generated data. Muscle mass catabolism occurs in every subject. Adjustment of these MRI-findings with biometrical and laboratory data will present further details regarding tissue metabolism and energy balance while running through a continent without any daily rest.

References

1. Machann J et al. J Magn Reson Imaging 2005; 21:455-462.
2. Würslin C. et al. J Magn Reson Imaging 2009 ; 31:430-439.

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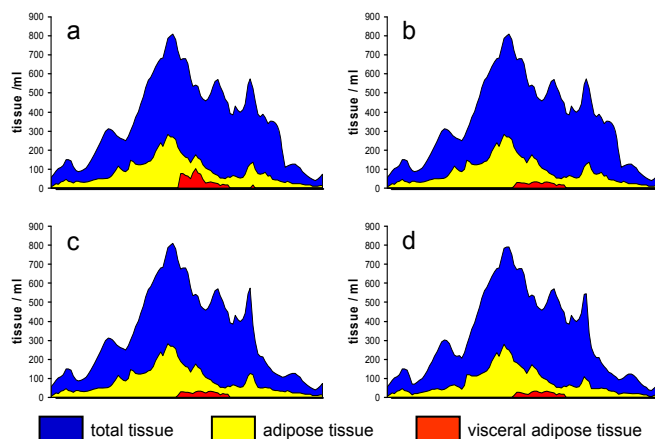


Figure 1: Whole-body tissue profiles of a 28-year-old male volunteer prior to the race. (a) Initial profile after automatic post-processing, (b) after extraction of intestinal tissue, (c) after excluding the head and (d) after extraction of yellow bone marrow.

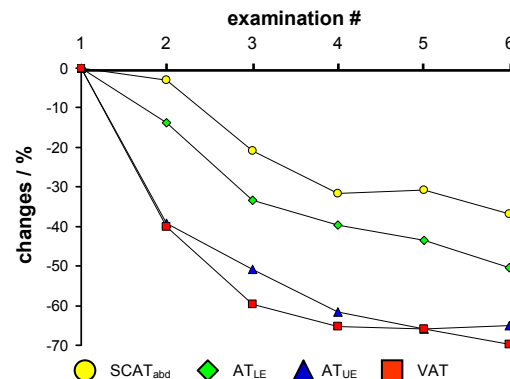


Figure 2: Changes of adipose tissue compartments during the race. Visceral adipose tissue and adipose tissue of the upper extremities show the fastest alterations.