EDITORIAL

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# Fat in spite of Exercise? An Alleged Paradigm Change Results from Calculation Mistakes

*Dick trotz Sport? Ein angeblicher Paradigmenwechsel beruht auf Rechenfehlern*

**For many years, I have read the popular magazine Scientific American, which treats many interesting topics from Big Bang to a variety of technical news.**

But I was puzzled by the eye-catcher on the February issue in 2017: "Workouts and weight loss…why exercise won't shed pounds." The anthropologist Herman Pontzer states in an article with the title "The Exercise Paradox" (2) that the energy expenditure of man depends markedly less on exercise activity than frequently assumed. How does he arrive at this conclusion?

Pontzer and colleagues have estimated daily exercise by use of accelerometers or the distance covered and measured energy expenditure with doubly labelled water in a large number of subjects in Africa and America (3, 4, 5). The subjects were North Americans (Afroamericans), members of the Hadza tribe in Tansania still living as hunter-gatherers, other Africans in Ghana and South Africa, farmers in South and Central America and Africa, inhabitants of Jamaica and the Seychelles, in each case males and females.

The Hadza, some hundred subjects, live as hunter-gatherers like in the Stone Age and are described by Pontzer et al. as people with relatively high physical activity. With bow and arrows, the males hunt animals they wait for at water holes; if they do not find prey, they climb trees in order to fetch honey from wild bee nests. However, they never run but walk, on an average 12km per day. This is much less than the last stone-age hunters in the Kalahari (Bushmen or San); they run up to 40km after antilopes and zebras until the animals collapse exhausted and are killed (6). The Hadza women collect seeds and fruit, which they partly dig out; the children carry water over long distances.

The farmers work hard without machines in their field especially for their own consumption (subsistence economy); partly they are living at high altitude (approx. 4000m above sea level) on the Altiplano in Bolivia. The North Americans are physically not very active, even if some of them work „manually". Athletes were not included, they were considered as "extreme cases".

The result of the investigations which are astonishing at first glance: With rising activity, energy expenditure rose only to approximately 3000kcal (12500kJ)/day, for higher exercise levels energy expenditure rose no more significantly. In other words: In spite of greater daily muscular work, daily energy expenditure was not greater in Hadza and farmers than in North Americans.

The authors conclude that there exists an energy saving mechanism which reduces the cost of other body functions. On the one hand, these are muscle activities not detected by accelerometers (e. g. more frequent sitting in spite of standing). Also activities contributing to energy expenditure at rest (brain, liver, kidneys, gut and other glands) shall be decreased; obviously this is possible only for a short time. The cost of reproduction, too, is mentioned. A limitation of the latter is occasionally present in athletes, e. g. in overtrained women (disturbances of menstruation, osteoporosis, eating disorders). During exhaustion after long-lasting strenuous exercise like triathlon or mountain hikes with gear, recreation energy expenditure is reduced possibly during sleep. It is known that Australian Aborigines reach this by lowering body temperature during deep sleep (8). But is energy saving by such mechanisms possible during more intensive professional work or regular sports?

Exercise physiologists estimate up to 4800kcal (20,000kJ) /day for heavy work (1). This limit is also valid for the average daily training load in sports because, in the long range, more cannot be eaten. On single days, however, up to 50,000kJ (12,000kcal) can be expended. But Pontzer et al. considered these as extreme cases, which they excluded. The highest group mean for daily exercise expenditure in their publications amounts to 3160kcal for North American males with 91.9kg mean body mass (3). Single values reach 3500kcal.

In order to judge the importance of Pontzer's investigations, several points have to be checked:

1. Do the methods used yield correct information?
2. Does the selection of subjects correspond to the topic?
3. Is the evaluation of the data relevant and correct?
4. Is the interpretation of the data correct?

## 1. Energy Expenditure and Mechanical Work

Determination of energy expenditure with doubly marked water ($H^2_2O$ und $H_2O^{18}$) is an established method for measurements lasting several days. The work performed was only estimated using accelerometry, because accelerations are measured as impulses/min but not as physical work. For this, the accelerometer has to be calibrated for each subject. Obviously this was not done. Also the apparatus used shows a large scattering of the measurements (7). ›

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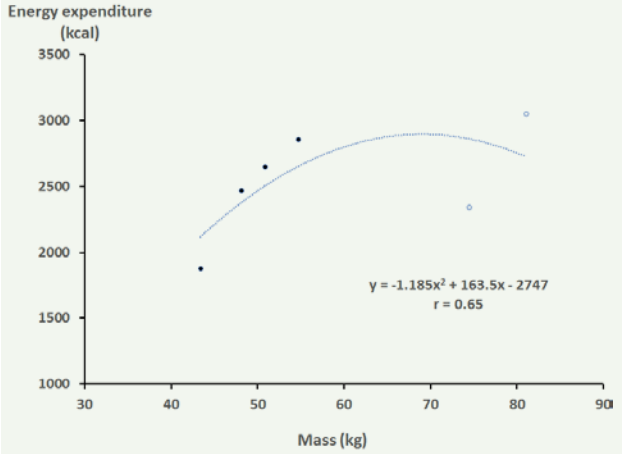


**Figure 1**

Daily energy expenditure in dependency on body mass. Mean values of physically active (Hadza and Bolivian, dots) and little-active (North Americans, circles) males and females. Data from (5).

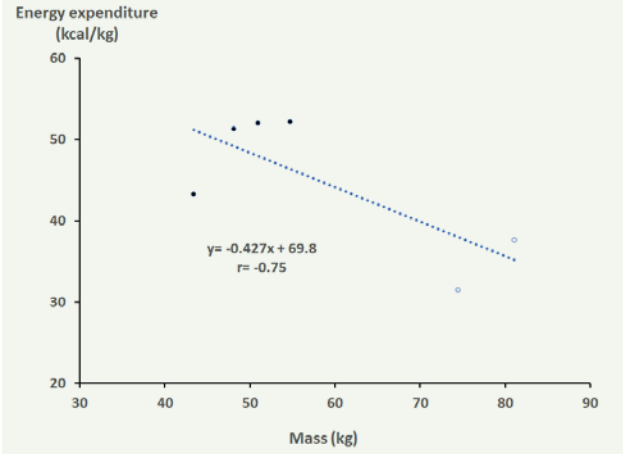


**Figure 2**

Daily energy expenditure per kg in dependency on body mass. Mean values of physically active (Hadza and Bolivian, dots) and little-active (North Americans, circles) males and females. Calculated from data in (5).

Possibly extreme differences resulted from this. For 200 impulses/min as daily mean, single energy expenditures of 1600 as well as of 3500kcal were obtained.

## 2. Selection of Subjects

Various groups with very different living conditions (climate, daily light duration, town or savanna, nutrition) are lumped together, thus increasing scattering. However, the countries of residence are considered as factors in the statistical analysis. But athletes are excluded without real justification.

## 3. Data Evaluation

The authors declare to have considered body shape and composition, but obviously energy expenditures were related only to fat free mass in addition to total body mass („controlling for lean mass and fat mass"). While there were great differences in height and mass (single values between 34 and 118kg in females, 43 and 101kg in males), energy expenditure is not given per kg body mass or kg fat free mass; to the contrary, it is presented absolutely with the consequence that a cloud of points appears without clear correlation in the figures.

I have made 2 figures with the mean values in tables (Fig. 1 and 2). As can be seen, the dependencies are reversed if related to kg body mass! Per kg the more heavily working groups obviously present an increased energy expenditure (males: per day ca. 52kcal/kg in Hadza and Bolivians, only 38kcal/kg in North Americans).

## 4. Interpretation of Data

The classical opinion that physically active subjects have an increased energy expenditure according to basic chemistry remains therefore unchallenged. It corresponds to the results of numerous studies since the 19th century (review e. g. in (9)). This does not exclude that one may become fat if more is eaten than energy consumed.

Therefore, the new theory of the authors who have performed such large and interesting studies is simply false. Unfortunately, it has caused a large reaction in the press and possibly will survive a while. The couch-potatoes will feel encouraged. What a pity!

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