

# ANALYSIS OF THE ENERGY BALANCE FROM SPECIFIC OXYGEN AND FOOD CONSUMPTION OF RATS DEVELOPING UNDER DIFFERENT CONDITIONS

T. G. Savkiv

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The body weight and the absolute and relative weights of the muscle mass are greater in rats made to carry out skeletal muscular work (running on a treadmill for a specified period) from the age of 1 to 7 months, than in control animals. Meanwhile their oxygen and food consumption (per unit weight) and their heart rate are lower than in the controls. These changes are more marked in males. It can be concluded from these results that rats developing during exposure to skeletal muscular work have a lower resting energy expenditure, a lower food requirement, and more economic activity of the heart than control animals.

The level of energy metabolism and the level of activity of the respiratory and cardiovascular systems in developing individuals of various species of mammals are determined by the pattern of function of the skeletal musculature at an early age. This dependence has been defined as the "energy rule of skeletal muscles" [1, 2, 4, 5].

The object of this investigation was to study the characteristics of the energy balance on the basis of the specific oxygen consumption and daily food intake of rats developing under ordinary conditions and also during exposure to skeletal muscular loading.

## EXPERIMENTAL METHOD

Experiments were carried out on noninbred male and female albino rats starting with the age of 1 month (weight 48-52 g). Observations continued for 6 months. The control rats were kept under ordinary conditions (males and females in separate cages). On alternate days the experimental rats performed muscular work by running on a treadmill. In the course of the experiment the duration of running was increased from 5 to 100 min at the age of 6 months. The oxygen consumption was recorded by the method of Kalabukhov and Grad [3], slightly modified in the laboratory, with the temperature in the respiration chamber 22-23°C. All the animals received a standard diet (No. 1 food concentrate). The 24-hourly food intake was determined daily. The heart rate was recorded electrocardiographically under conditions of complete rest and quiet (20-30 min after fixation of the electrodes). The weight of the animals and the total weight of the muscle mass were determined.

## EXPERIMENTAL RESULTS

The results are given in Table 1.

Clearly the weight of the experimental rats, both males and females, exceeded the control value. The difference was particularly marked at the age of 7 months. The greater weight of the experimental animals was due chiefly to an increase in both the absolute and the relative weights of the muscle mass.

The considerable economy in the expenditure of energy, estimated from the level of the oxygen consumption, in the experimental rats compared with the controls is noteworthy. The oxygen consumption of

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Laboratory of Age Physiology and Pathology, Institute of Normal and Pathological Physiology, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR N. A. Fedorov.) Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 77, No. 5, pp. 8-10, May, 1974. Original article submitted July 13, 1973.

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TABLE 1. Oxygen Consumption, Food Intake, Heart Rate, Body Weight, and Weight of Muscle Mass of Control and Experimental Rats ( $M \pm m$ )

Age (in months)	Parameter studied	Females ( $M \pm m$ )		Males ( $M \pm m$ )	
		control	exptl.	control	exptl.
4	Weight (in g)	248,0 $\pm$ 5,8	264,0 $\pm$ 3,2*	349,0 $\pm$ 6,0	362,7 $\pm$ 8,5*
	Heart rate (beats/min)	360,0 $\pm$ 5,1	302,9 $\pm$ 13,8	305,0 $\pm$ 9,1	265,6 $\pm$ 8,5
	O <sub>2</sub> consumption (in ml/kg/min)	38,2 $\pm$ 0,1	30,9 $\pm$ 0,1	33,2 $\pm$ 0,1	25,7 $\pm$ 0,1
	Food intake (in kcal/day/kg)	179,6 $\pm$ 5,8	168,9 $\pm$ 5,7*	174,9 $\pm$ 2,3	147,7 $\pm$ 3,9
	Weight of muscle mass: absolute (in g)	97,3 $\pm$ 3,0	119,7 $\pm$ 1,4	145,3 $\pm$ 4,5	178,3 $\pm$ 3,9
7	relative (in %)	38,6 $\pm$ 0,3	43,2 $\pm$ 0,4	40,2 $\pm$ 0,4	45,0 $\pm$ 0,3
	Weight (in g)	276,8 $\pm$ 10,7	318,2 $\pm$ 7,6	445,0 $\pm$ 6,5	526,0 $\pm$ 8,9
	Heart rate (beats/min)	340,0 $\pm$ 0,4	285,9 $\pm$ 9,9	295,8 $\pm$ 9,3	257,1 $\pm$ 5,6
	O <sub>2</sub> consumption (in ml/kg/min)	29,1 $\pm$ 0,4	21,3 $\pm$ 0,1	21,8 $\pm$ 0,4	17,2 $\pm$ 0,1
	Food intake (in kcal/day/kg)	206,6 $\pm$ 2,2	150,9 $\pm$ 4,3	197,3 $\pm$ 2,8	146,4 $\pm$ 4,1
	Weight of muscle mass: absolute (in g)	109,4 $\pm$ 3,8	139,2 $\pm$ 4,4	186,8 $\pm$ 3,4	236,7 $\pm$ 4,8
	relative (in %)	39,9 $\pm$ 0,6	43,5 $\pm$ 9,6	41,6 $\pm$ 0,3	46,0 $\pm$ 0,7

\*Values do not differ from control ( $P > 0.05$ ).

the experimental rats was reduced by the age of 4 months and it was still falling at the age of 7 months. It is important to note that the specific oxygen consumption in the males of both groups was higher than in the females.

The heart rate of the experimental rats of both sexes was slower than in the controls. Besides the greater weight of the experimental rats and their lower oxygen consumption, their daily food intake also was lower than in the control series. This difference appeared sooner (by the age of 4 months) in the experimental males than in the females. Economy of energy expenditure at rest was greater in the males than in the females in both the control and the experimental series. Females performing skeletal muscular work during their development only resembled the control males in some parameters (heart rate, oxygen consumption) at the age of 7 months, and with respect to other parameters (total body weight, absolute weight of muscle mass) they were actually behind them.

It can be concluded from these findings that development associated with performance of skeletal muscular work induces a higher degree of induction of both the first and the second form of excess anabolism [1, 2] and is characterized by a lower expenditure of energy and a lower food intake (per unit weight), as well as by a lower heart rate than development under ordinary conditions.

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