AN ANALYSIS OF THE PECULIARITIES IN ENERGY EXPENDITURE IN DOGS AT DIFFERENT AGE PERIODS

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From comparative ontogenetic researches carried out in the laboratory, it has been established that the changes and transformations in the activity of the respiratory and cardio-vascular systems during the process of postnatal ontogenesis in various species of animals depend, not on the "energy surface rule" as used to be accepted [14], but on a peculiar feature in the corresponding development of the skeletal musculature [1-6, 12]. These researches induced us to carry out a comparative ontogenetic study of the changes in energy expenditure at different age periods. Of special interest in this sense is the dog in which, during postnatal ontogenesis (as distinct from certain other mammals), a vagal regulation of the activity of the heart is developed. We were unable to find in the literature any systematic investigations devoted to the study of the peculiarities in the changes of energy expenditure in the dog throughout life from birth to maturity. Articles dealing with a study of the gas exchange taking place in the dog during different age periods are given in the literature cited below [7, 9, 10, 11, 13, 16].

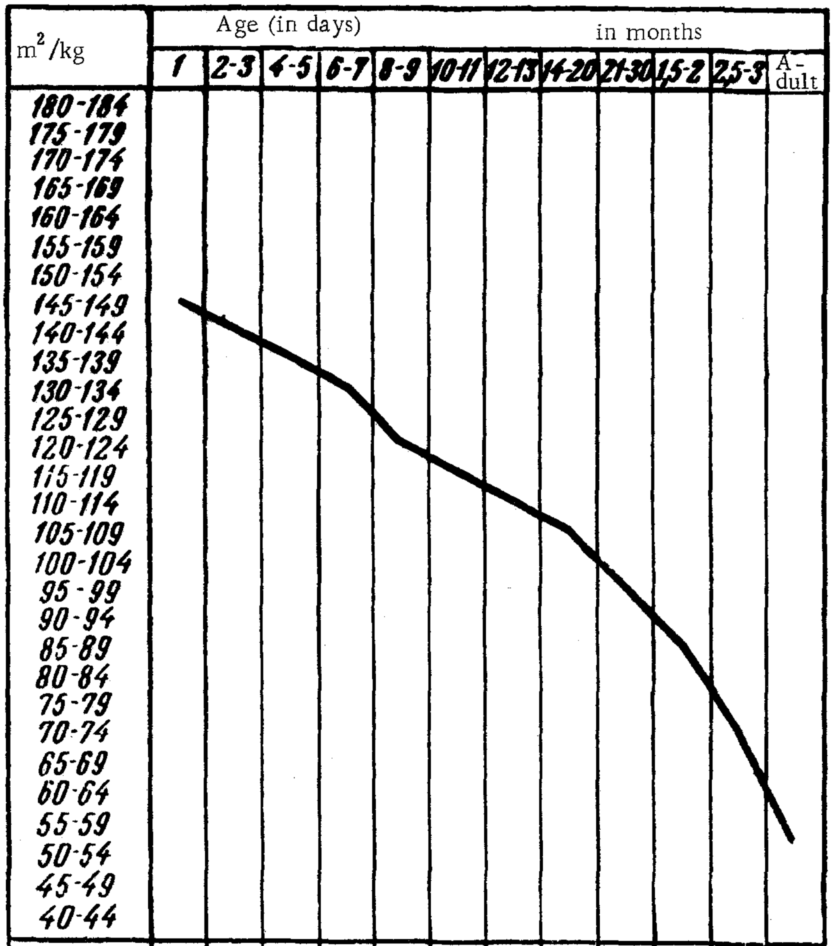
The problem in the present work was to examine the oxygen consumption involved in energy expenditure in a normally developing dog at different age periods from birth to the adult stage.

METHODS

The determination of oxygen consumption was carried out in a respiration chamber similar to that described by N. I. Kalabukhov [8] and Grad [14].

The dimensions of the respiration chambers used depended on the age of the experimental animal. The chamber was placed in a bath maintained at the requisite temperature. An autoclave of suitable dimensions and especially adapted for the purpose was employed for investigating the oxygen consumption of adult dogs. The animals were first of all kept for a period of 20-30 min in the respiration chamber immersed in the bath. Readings of the level of oxygen consumption were made over five-minute intervals during a 15 min exposure. The use of glass chambers enabled visual observations to be made on the condition and behavior of the experimental animals. Experiments in which there was no consistency in the values registered over five-minute intervals were not taken into account. With the aid of a special thermoprobe, connected with an electrothermometer, rectal temperatures were measured up to and immediately after making an experimental observation. The oxygen consumption was determined in the chamber at a temperature corresponding to that of the vivarium (19-22°).

For measuring the oxygen consumption corresponding to the basal metabolism, adult dogs and whelps eighteen months old were used and were placed in the chamber 12-16 h after a meal. A short period of alertness occurred in the young whelps during suckling times after which they were contented for 2.5-3 hours. If the opportunity for the whelps to take milk was eliminated by alternate stimulation of the food center, then the sharp increase registered in the oxygen consumption connected with the motor feeding reactions cannot be accepted as normal. On the contrary, during a longer starvation period the body temperature of the whelp begins to drop and leads to a reduction in the oxygen consumption. Consequently, young whelps were put into the respiration chamber 1-1½ hours after accepting food. When they were 16-18 days old, examinations could be made as soon as 5-6 h after taking food.



	1	2-3	4-5	6-7	8-9	10-11	12-13	14-20	21-30	1,5-2	2,5-3	Adult
Number of experiments	25	33	27	40	24	29	22	31	21	22	27	23
Mean	146,3	142,5	138,6	131,5	123,9	117,8	112,0	106,9	100,5	87,7	74,7	51,6
SD	2,0	1,3	2,1	1,8	2,3	1,4	1,6	0,9	2,0	1,8	1,8	2,6

Fig. 1. Changes in the relative surface area of the body in dogs during postnatal ontogenesis.

With the aim of preventing a drop in the body temperature of the whelps while they were in the respiration chamber and in order to make conditions as near natural as possible, a special wadded housing was constructed.

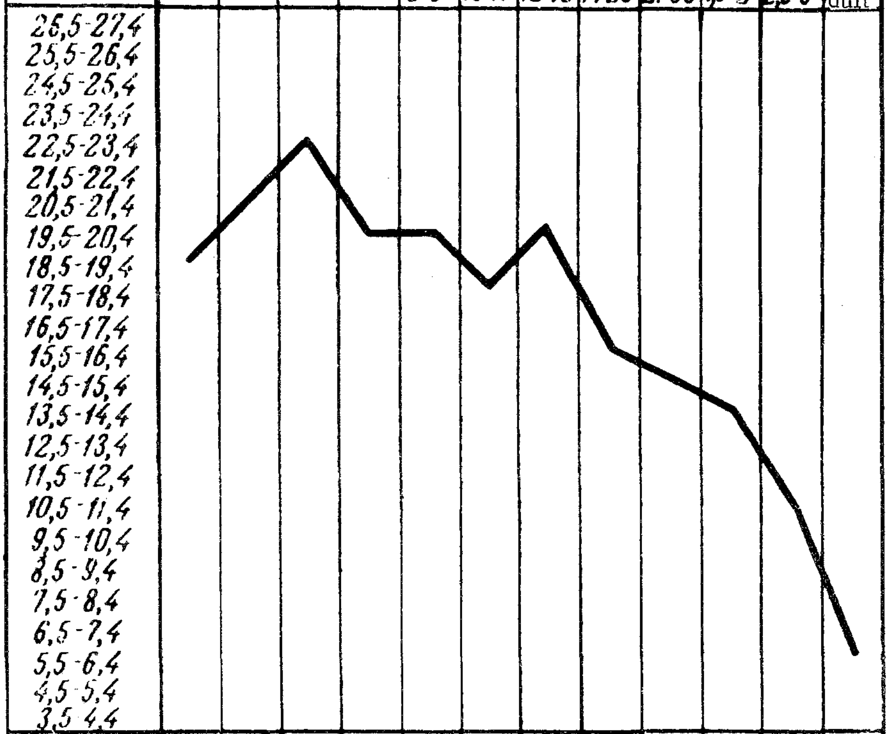
The values for oxygen consumption obtained in the experiments were converted and based on unit weight and unit surface of the body. The surface area of the body was calculated from Meyer's formula

$$S = K\sqrt[3]{P^2}$$

where S = surface area of the body; P = weight of body; K = a coefficient which for adult dogs and whelps over 1 kg in weight was 11.2 and for whelps less than 1 kg in weight was 10.1. Three hundred and thirty experiments were made on 180 dogs.

RESULTS

The curve in Fig. 1 shows the changes in the relative values for the surface area of the body in dogs from birth to maturity. According to the "energy surface rule," the curve following the changes in oxygen consumption per unit body weight should correspond closely with the curve showing the changes in the relative values for surface area of the body, but the curve showing the increase in oxygen consumption per unit surface area should be a horizontal line. Fig. 2 represents the curve connecting the level of oxygen consumption with unit body weight and Fig. 3 is the curve in which oxygen consumption is plotted against unit surface area at different ages.



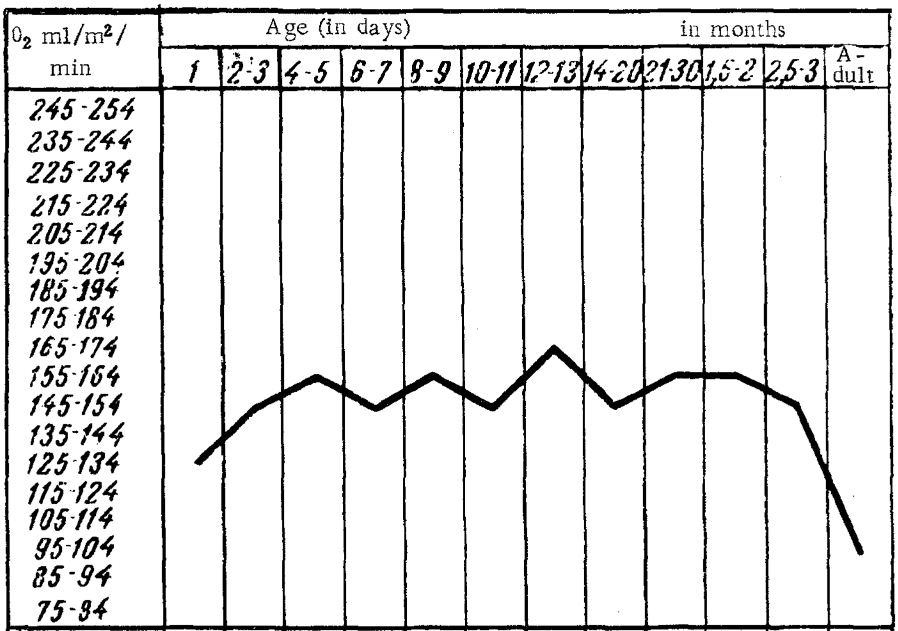
O_2 ml/kg/min	Age (in days)								in months			
	1	2-3	4-5	6-7	8-9	10-11	12-13	14-20	21-30	1,5-2	2,5-3	Adult
Number of experiments	25	27	27	40	24	29	22	31	24	22	27	25
Mean	19,0	21,6	23,0	19,0	19,5	17,6	19,3	15,6	15,2	14,3	11,3	5,5
SD	0,9	0,44	0,57	0,52	0,84	0,53	0,64	0,33	0,53	0,32	0,27	0,18

Fig. 2. Changes in oxygen consumption per unit body weight in dogs during postnatal ontogenesis.

Before analysing the curves it is necessary, first of all, to eliminate the results obtained on the first day of life when the body temperature of the whelp was 30-33° and the oxygen consumption amounted to 19 ± 0.9 ml/kg/min or 129 ± 5.75 ml/m²/min. In the very early hours of life the level of oxygen consumption was still lower, being equal on an average to 15 ml/kg/min. But from the second day after bith the oxygen consumption per unit weight and surface area increased. The 4th-5th day must be excluded because at that period the body temperature of the dog, not in the special wadded housing within the respiration chamber, dropped one or two degrees.

Four or five days after birth the body temperature increased to 35.5-37°. The oxygen consumption, both per unit weight and per unit surface area, also increased although the corresponding value for surface area of the body decreased. From the 4-5th day to the 12-13th day of life the body temperature was stationary at 37-37.5°. During that period the oxygen consumption, both per unit weight and per unit surface area, fluctuated within comparatively narrow limits. On the 18-20th day the body temperature reached 38° and when the dogs were a month old it was 38.5°, which is the temperature of an adult dog. The rise in oxygen consumption at this time, both per unit weight and per unit surface area, could be attributed to a rising body temperature. In spite of this, we did not observe a straight line relationship between the changes in body temperature and those in oxygen consumption per unit surface area.

The reduction in oxygen consumption, which has been demonstrated, began on the 12-13th day at a time when the standing pose was being stabilized (see Fig. 2) with the help of the forelimbs. The next drop in this value was noted on the 18-20th day when the standing pose involved the hindlimbs as well. Finally, a greater reduction took place when the dog, two months old, had quite mastered the act of locomotion and had become independent of its mother.



O_2 ml/m²/min	1	2-3	4-5	6-7	8-9	10-11	12-13	14-20	21-30	1,5-2	2,5-3	Adult
Number of experiments	25	27	27	40	24	29	22	31	24	22	27	25
Mean	129,6	148,6	155,6	151,0	158,0	151,7	167,3	147,4	155,0	164,5	151,8	101,6
SD	5,75	3,42	4,3	4,5	5,8	4,5	5,0	3,0	6,4	7,0	4,9	1,9

Fig. 3. Changes in oxygen consumption per unit surface area of the body in dogs during postnatal ontogenesis.

Attention should be paid to the similarity between the curves showing the changes in oxygen consumption per unit weight and per unit surface area of the body during the process of postnatal ontogenesis. The differences between them concern only the growth period from the 20th to the 60th day when oxygen consumption per unit surface area again begins to rise. In the over-all similarity between the curves, considerable quantitative differences can be observed. Thus, from birth to maturity, the oxygen consumption per unit body weight drops almost 3.5 times whereas, if it is based on unit surface area, it drops only 1.3 times. The maximum level of oxygen consumption per unit weight occurs on the 4-5th day, but in the adult stage it is 4.2 times less. The maximum oxygen consumption estimated on unit surface area occurs on the 12-13th day, but in the adult stage the level is only 1.6 times lower.

From an analysis of the data obtained it can be concluded that the changes in the level of oxygen consumption, estimated both on unit weight and unit surface area, during the process of postnatal ontogenesis is not related solely to the energy surface rule. The observed relationship appears to be far more complex than the law of surface requires and it needs further special study.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. ***Some or all of this periodical literature may well be available in English translation.*** **A complete list of the cover-to-cover English translations appears at the back of this issue.**