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Relationship between basal metabolic rate, muscle strength and aging

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Basal Metabolic Rate (BMR), along with mass, is one of the main characteristics of a species in comparative physiology. Despite the fact that this indicator is periodically criticized, it remains an important measure of the energy expenditure of the body. Of particular interest is the relationship of energy metabolism with aging. Both interspecific and intraspecific comparative studies of the relationship of BMR with life span and other indicators are being conducted. The results so far do not look unambiguous; for example, it has been shown that BMR does not correlate with longevity in eutherians or birds, if a correction for mass is introduced [1]. At the same time, it is clear that passerine birds with high BMR live significantly longer than mammals of the same size.

The body undergoes significant changes during development and aging, so if we look at changes in metabolism in individuals during ontogeny, we will find that BMR probably also changes during life. Previously, it was thought that BMR in humans falls all the time with age, however, in the latest, more detailed and covering a large sample of people study, it was found that the decrease in metabolic rate occurs only after 60 years [2]. Starting from the age of 60, age-related pathologies begin to manifest themselves more clearly, and this probably does not coincide with a decrease in BMR.

Many researchers attribute higher BMR to higher production of reactive oxygen species. In this regard, in long-lived bird species, many researchers are looking for distinctive characteristics that help them in the fight against oxidative stress. However, it has not yet been possible to establish any features – for example, no special composition of fatty acids has been found in cell membranes in long-living birds compared to other ones [3]. In our opinion, it is necessary to look for the reasons for longevity not only in the ability to withstand oxidative stress. The fall in metabolism in people of older age groups is probably due to a loss in the mass and strength of muscle fibers, which is expressed in their atrophy and sarcopenia, as well as in violation of anabolic processes in muscles. It is no coincidence that healthy people after 60 and 70 years of age show on average about 20–40 % lower results in isometric strength tests than young people, and in very old people the decrease is even more noticeable [4]. As is known, skeletal muscles are the main consumer of insulin and, accordingly, glucose; it is actively involved in the use of energy received from food (postprandial blood glucose levels). In this regard, skeletal muscles largely determine the development of insulin resistance. Passerines have a special flight style that requires more energy, so their BMR is higher than in non-passerines [5]. This probably also contributes to the fact that passerine birds have a well-developed glucose sensitivity support system, an extensive network of mitochondria, and many other adaptations for high BMR. In our opinion, it makes sense for researchers dealing with the question of the relationship between metabolism and longevity to take

into account the anatomy, physiology, and biochemistry of muscles in both comparative and longitudinal studies.

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References

1. Magalhães J.P., Costa J., Church G.M. An analysis of the relationship between metabolism, developmental schedules, and longevity using phylogenetic independent contrasts. *J Gerontol A Biol Sci Med Sci.* 2007;62(2):149-160.
2. Pontzer H. et al. Daily energy expenditure through the human life course. *Science.* 2021;373(6556):808-812.
3. Montgomery M.K., Hulbert A.J., Buttemer W.A. Metabolic rate and membrane fatty acid composition in birds: a comparison between long-living parrots and short-living fowl. *J Comp Physiol B.* 2012;182(1):127-137.
4. Vandervoort A.A. Aging of the human neuromuscular system. *Muscle Nerve.* 2002;25(1):17-25.
5. Gavrilov V.M. Energy expenditures for flight, aerodynamic quality, and colonization of forest habitats by birds. *Biol Bull.* 2011;38(8):779-788.