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# Is Physical Exercise Capable of Beginning the Powerful Tool for Regulation of Brown Adipocytes Activity?

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## Mini Review

In mammals, it has been widely accepted that there are three types of adipocytes; white adipocytes, brown adipocytes, and beige adipocytes. White adipocytes are comprised of unilocular large lipid droplet that can store triglycerides as energy, and they play a key role in energy metabolism by providing free fatty acids and glycerol through the hydrolysis of triglycerides [1]. In contrast, brown adipocytes are comprised of multilocular lipid droplet with rich mitochondria into their cell bodies. Function of numerous mitochondria in brown adipocytes is to provide the heat production through free fatty acids which are sourced from hydrolysis of multilocular lipid droplet, thereby increasing in whole body energy expenditure [2]. Moreover, the research done over the past decade have demonstrated that beige adipocytes are identified within white adipocytes that express high levels of uncoupling protein-1 (UCP-1), a marker of brown adipocyte, and contributes thermogenesis [3]. These cells can permit distinction from brown adipocytes via expression of such as Tmem26 and CD137, surface markers of beige adipocytes [4]. Thus, it has considered that systemic energy metabolisms in mammalian bodies are regulated, at least in part, through differencein physiological role of three types of adipocytes.

There are growing body of evidences that prolonged physical exercise training in the mouse results in production of beige adipocytes in subcutaneous white adipocytes [5]. On the other hand, it has shown that caroligenic action of beige adipocytes, which also stimulate energy expenditure, have low levels relative to brown adipocytes themselves [4], suggesting that increase in the number of brown adipocytes would be beneficial for prevention and therapy of obesity and its related disorders. However, there has been little consensus regarding effect of physical exercise on function of brown adipocytes; some studies have shown to increase in activity of brown adipocytes, others have demonstrated no alteration of activity of brown adipocytes, and another study has reported a reduction of brown adipocytes activity by exercise training.

Of note, exercise pattern may appear to affect the outcome of previous studies. Study in mouse has demonstrated that treadmill running training for 6 weeks results in increase in oxygen consumption of brown adipocytes [6], as well as increased expression of UCP-1 and other brown adipocytes-specific genes [7,8]. Moreover, several other studies have indicated that running training has no effect on brown adipocyte activity in interscapularregion [9-11]. In addition, it has reported that activity of brown adipocytes are significantly attenuated by running training compared with sedentary control [12-16], suggesting that results obtained from running training vary greatly among studies. The reason for this discrepancy can be potentially explained by phenomenon that brown adipocytes-induced non shivering thermogenesis is unnecessary because running is able to produce heat from contraction of skeletal muscles themselves.

Contrastingly, it has reported that swimming training activates function of brown adipocyte via increase in thermogenesis capacity [17-21]. Several lines of studies, however, have shown that there are no alterations in activity of brown adipocytes [22,23], as well as significantly decrease [24] by swimming training. Especially, the reduced activity of brown adipocytes by swimming training was observed after 21days of exercise training [24], suggesting that swimming training-induced activation of brown adipocytes might be associated with period of exercise training. This concept would be supported by results of previous studies that activation of brown adipocytes by swimming training requires for 6 weeks or longer [17-21]. Together, swimming training would tend to be beneficial as a physiological stimulator of exercise training-induced activation of brown adipocytes, because there are few reports of opposite

outcomes compared with results of running training. Consequently, expose body to water, which provokes a heat production via activation of sympathetic nervous system, could be a probable trigger for swimming training-medicate hyper-function of brown adipocytes.

Interestingly, in human, it has shown that there is a very strong seasonal variation in thermogenic function of brown adipocytes [25]. Therefore, conflicting results obtained from previous studies might be corrected to standardize the experimental seasons. Further studies are required to fully elucidate the mechanism underlying physical exercise-mediated adaptation of brown adipocytes, and to advance this information to elucidate novel therapeutic target for obesity and its related disorders.

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