Journal of Yoga & Physical Therapy

Kaliman, J Yoga Phys Ther 2014, 4:1
DOI: 10.4172/2157-7595.1000152

Perspective | Open Access

The Value of Exercise Training for Prevention and Complementary Treatment of Brain Aging and Neurodegeneration

Perla Kaliman*

Instituto de Investigaciones Biomédicas de Barcelona IIBB-CSIC-IDIBAPS, c/Rossellon 161, 6th floor, E-08036 Barcelona, Spain

It is widely documented that sedentarism is a risk factor for most common age-related chronic diseases. Regarding brain's health, there is increasing evidence of the beneficial effects of aerobic physical exercise on synapse and general brain function, at both young and old ages and in both healthy and pathological states [1]. Indeed, in adult animals, physical training has been shown to enhance performance in learning and memory tasks [2-4], increase neuronalproliferation [5-7], and affect neuronal structure and the functionality ofcellular mechanisms associated with learning processes [8,9]. In addition, several studies using transgenic mouse models of Alzheimer's disease (AD) have demonstrated the protective effects of aerobic exercise against neurodegeneration [10,11].

Although transcriptional responsiveness varies over the lifetime, many brain genes still seem to be responsive to exercise in old animals and in animal models for neurodegenerative diseases [12-14]. In mice, brain gene expression is sensitive to physical exercise, particularly in the hippocampus [15-19]. These findings are particularly relevant because the hippocampus is especially susceptible to dysfunctional and degenerative processes during aging or in Alzheimer's disease, plays a key role in learning and memory processes and is involved in the regulation of mood and antidepressant responses [20-22]. Using the senescence-accelerated SAMP8 mouse a non-transgenic model for studying aspects of progressive cognitive decline and Alzheimer's disease (AD) we have recently shown that exercise training during adulthood (6 months of voluntary training on a running wheel, 3 alternate days per week) prevented or delayed processes associated with aging [23]. Upon completion of the long-term intervention, SAMP8 mice were at the final stage of their lives (their median life is 9.7 months [24]), however they were still voluntarily running and showed improvement in several aging traits compared with the sedentary controls. We found that the exercise intervention ameliorated their skin color, decreased body tremor, increased hippocampal vascularization and modulated the expression of the brain derived neurotrophic factor (*Bdnf*) gene as well as several extracellular matrix gene alterations in the hippocampus. Recent data have described that epigenetic modifications seem to be involved in the peripheral and central effects of physical exercise [25]. Notably, we have recently observed epigenetic changes in specific microRNA (miRNA) and histone acetylation levels in the hippocampus of senescent SAMP8 mice in response to 8 weeks of voluntary wheel running (Cosin-Tomas et al., unpublished data).

In sum, there is a growing body of research showing the neurophysiological aging-protective responses elicited by exercise training. Moreover, a still limited but fascinating field has begun to describe the epigenetic impact of physical exercise in peripheral tissues and in the brain. Unveiling the exercise-responsive mechanisms of chromatin regulation and their pathophysiological implications may lead to the development of new preventive and/or therapeutic interventions for age-related disorders, including neurodegenerative conditions.

References

1. Párrizas M, Gasa R, Kaliman P (2012) Epigenetics of Lifestyle. Bentham Science Publishers.
2. Fordyce DE, Wehner JM (1993) Physical activity enhances spatial learning performance with anassociated alteration in hippocampal protein kinase C activity in C57BL/6 and DBA/2 mice. Brain Res 619: 111-119.
3. Gomez-Pinilla F, So V, Kesslak JP (1998) Spatial learning and physical activity contribute to the induction of fibroblast growth factor: neural substrates for increased cognition associated with exercise. Neuroscience 85: 53-61.
4. van Praag H, Shubert T, Zhao C, Gage FH (2005) Exercise enhances learning and hippocampal neurogenesis in aged mice. J Neurosci 25: 8680-8685.
5. Kim YP, Kim H, Shin MS, Chang HK, Jang MH, et al. (2004) Age-dependence of the effect of treadmill exercise on cell proliferation in the dentate gyrus of rats. Neurosci Lett 355: 152-154.
6. Uysal N, Tugyan K, Kayatekin BM, Acikgoz O, Bagriyanik HA, et al. (2005) The effects of regular aerobic exercise in adolescent period on hippocampal neuron density, apoptosis and spatial memory. Neurosci Lett 383: 241-245.
7. van Praag H, Kempermann G, Gage FH (1999) Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. Nat Neurosci 2: 266-270.
8. Farmer J, Zhao X, van Praag H, Wodtke K, Gage FH, et al. (2004) Effects of voluntary exercise on synaptic plasticity and gene expression in the dentate gyrus of adult male Sprague-Dawley rats *in vivo*. Neuroscience124: 71-79.
9. Garza AA, Ha TG, Garcia C, Chen MJ, Russo-Neustadt AA (2004) Exercise, antidepressant treatment, and BDNF mRNA expression in the aging brain. Pharmacol Biochem Behav 77: 209-220.
10. van Praag H (2009) Exercise and the brain: Something to chew on. Trends Neurosci 32: 283-290.
11. Archer T (2011) Physical exercise alleviates debilities of normal aging and Alzheimer's disease. Acta Neurol Scand 123: 221-238.
12. Garcia-Mesa Y, Lopez-Ramos JC, Gimenez-Llort L, Revilla S, Guerra R, et al. (2011) Physical exercise protects against Alzheimer's disease in 3xTg-AD mice. J Alzheimers Dis 24: 421-454.
13. Kohman RA, Rodriguez-Zas SL, Southey BR, Kelley KW, Dantzer R, et al. (2011) Voluntary wheel running reverses age-induced changes in hippocampal gene expres- sion. PLoS One 6: e22654.
14. Parachikova A, Nichol KE, Cotman CW (2008) Short-term exercise in aged Tg2576 mice alters neuroinflammation and improves cognition. Neurobiol Dis 30: 121-129.
15. Bekinschtein P, Oomen CA, Saksida LM, Bussey TJ (2011) Effects of environmental enrichment and voluntary exercise on neurogenesis, learning and memory, and pattern separation: BDNF as a critical variable? Semin Cell Dev Biol 22: 536-542.
16. Christie BR, Eadie BD, Kannangara TS, Robillard JM, Shin J, et al. (2008) Exercising our brains: How physical activity impacts synaptic plasticity in the dentate gyrus. Neuromolecular Med 10: 47-58.

***Corresponding author:** Perla Kaliman, Ph.D, Head of Epigenetics of Lifestyle Group, Aging and Neurodegeneration Team, IIBB-CSIC, IDIBAPS, c/Rosselló 161, 6th floor, 08036 Barcelona, Spain, Tel: +34 93 363 83; E-mail: pkaliman@clinic.ub.es

Received December 23, 2013; **Accepted** January 23, 2014; **Published** January 27, 2014

Citation: Kaliman P (2014) The Value of Exercise Training for Prevention and Complementary Treatment of Brain Aging and Neurodegeneration. J Yoga Phys Ther 4: 152. doi:10.4172/2157-7595.1000152

17. van Praag H (2008) Neurogenesis and exercise: Past and future directions. Neuromolecular Med 10: 128-140.

18. Yau SY, Lau BW, So KF (2011) Adult hippocampal neurogenesis: A possible way how physical exercise counteracts stress. Cell Transplant 20: 99-111.

19. Wrann CD, White JP, Salogiannnis J, Laznik-Bogoslavski D, Wu J, et al. (2013) Exercise Induces Hippocampal BDNF through a PGC-1α/FNDC5 Pathway. Cell Metab 18: 649-659.

20. Hunsberger JG, Newton SS, Bennett AH, Duman CH, Russell DS, et al. (2007) Antidepressant actions of the exercise-regulated gene VGF. Nat Med 13: 1476-1482.

21. Molteni R, Ying Z, Gomez-Pinilla F (2002) Differential effects of acute and chronic exercise on plasticity-related genes in the rat hippocampus revealed by microarray. Eur J Neurosci 16: 1107-1116.

22. Tong L, Shen H, Perreau VM, Balazs R, Cotman CW (2001) Effects of exercise on geneexpression profile in the rat hippocampus. Neurobiol Dis 8: 1046-1056.

23. Alvarez-López MJ, Castro-Freire M, Cosín-Tomás M, Sanchez-Roige S, Lalanza JF, et al. (2013) Long-term exercise modulates hippocampal gene expression in senescent female mice. J Alzheimers Dis 33: 1177-1190.

24. Takeda T (2009) Senescence-accelerated mouse (SAM) with special references to neurodegeneration models, SAMP8 and SAMP10 mice. Neurochem Res 34: 639-659.

25. Kaliman P, Parrizas M, Lalanza JF, Camins A, Escorihuela RM, et al. (2011) Neurophysiological and epigenetic effects of physical exercise on the aging process. Ageing Res Rev 10: 475-486.