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Research report

# Prior regular exercise prevents synaptic plasticity impairment in sleep deprived female rats

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ABSTRACT

Previous studies have indicated that physical exercise plays a preventive role in synaptic plasticity deficits in the hippocampus of sleep-deprived male rats. The objective of the present study was to evaluate the effects of treadmill running on early long term potentiation (E-LTP) at the Cornu Ammonis (CA1) area of the hippocampus in sleep-deprived female rats.

Intact and ovariectomiezed (OVX) female Wistar rats were used in the present study. The exercise protocol was four weeks treadmill running and the multiple platform method was applied to induce 72 h sleep deprivation (SD). We examine the effect of exercise and/or SD on synaptic plasticity using in vivo extracellular recording in the CA1 area of the hippocampus. The field excitatory post-synaptic potential (fEPSP) slope was measured before and 2 h after high frequency stimulation (HFS) in the experimental groups.

Field potential recording indicated that the induction and maintenance phase of E-LTP impaired in the sleep deprived animals compared to the other groups. After 72 h SD, E-LTP impairments were prevented by 4 weeks of regular treadmill exercise.

In conclusion, the synaptic plasticity deficit in sleep-deprived female rats was improved by regular physical exercise. Further studies are suggested to evaluate the possible underlying mechanisms.



## 1. Introduction

Sleep has an important role in the acquisition and retention of new information in the hippocampus. Several behavioral, physiological, cellular and molecular studies suggest that sleep plays an important role in memory consolidation (Datta, 2010; Diekelmann and Born, 2010; Gais et al., 2006) and sleep loss leads to neurocognitive impairments (McCoy and Strecker, 2011). Furthermore sleep deprivation prior to learning decreases learning ability and impairs memory, while sleep deprivation after learning disrupts memory formation (Diekelmann and Born, 2010).

Chronic sleep restriction is a growing problem in many countries and modern societies. Sleep disorder is a common complaint among women since they report more sleep difficulties in comparison with men. In addition, sleep problems are reported to be more frequent during the menopausal and post-menopausal periods compared with pre-menopausal periods in women (Dzaja et al., 2005; Luyster et al., 2012; Manber and Armitage, 1999). Some studies have suggested that level of estrogen may play a role in regulating sleep (Manber and Armitage, 1999) and cognitive functions (Kramár et al., 2013). The role of female sex steroids in sleep regulation is particularly obvious in postmenopausal women, who have low levels of circulating estrogen (Dzaja et al., 2005; Manber and Armitage, 1999) and are more vulnerable to deleterious effects of poor sleep on cognitive performance (Alhola et al., 2005).

Evidence indicated a strong correlation between sleep deprivation and cognitive impairment in humans and animals (Alvarenga et al., 2008; Curcio et al., 2006). Accordingly, sleep deprivation negatively impacts hippocampus dependent learning and memory and long term potentiation (Tartar et al., 2006), which is a form of synaptic plasticity accepted as a biological model of learning and memory (Bliss and Collingridge, 1993; Malenka and Bear, 2004). Similar studies have indicated that 24 h sleep deprivation impairs spatial

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