



Mental stress and exercise training response: stress-sleep connection may be involved

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A commentary on

Self rated mental stress and exercise training response in healthy subjects

by Ruuska, P. S., Hautala, A. J., Kiviniemi, A. M., Mäkikallio, T. H., and Tulppo, M. P. (2012). *Front. Physiol.* 3:51. doi: 10.3389/fphys.2012.00051

Ruuska et al. (2012) showed that individual responses to exercise training may vary as a function of the baseline self-rated mental stress among healthy volunteers after a highly controlled aerobic training intervention. The changes in fitness were poor or absent in the subjects who reported their psychological resources as low and reported having a lot of stressors in their lives prior to the intervention. The authors presented some potential mechanisms that could explain their findings, highlighting the role of stress-related hormonal changes in the training response. Our brief comment aims to contribute to the discussion by adding a complementary explanation that could help to clarify these interesting findings. Our hypothesis is that the connection between sleep disturbance and mental stress could also be involved in the results from Ruuska et al. (2012).

It is well known that sleep quantity and quality are associated with mental stress and vice versa (Basishvili et al., 2011; Dorrian et al., 2011; Heffner et al., 2012; Kachikis and Breitkopf, 2012; Kashani et al., 2012). Thus, it is possible that sleep deprivation lowers the psychological threshold for the perception of stress from cognitive demands (Minkel et al., 2012). Recently, Kashani et al. (2012) suggested that the stress-sleep connection may be an important mechanistic mediator of the association between stress and cardiovascular disease. In the same way, we hypothesize that stress-sleep connection may be an important mechanism in the relationship between mental stress and the exercise training response.

Sleep is widely known to be an important component of recovery from training (Leeder et al., 2012) and new data continue to elucidate the association between sleep disturbances and muscle pathophysiology. For example, Dattilo et al. (2011) hypothesized that sleep debt could, paradoxically, provoke loss of muscle mass after damage induced by exercise, hindering muscle recovery. The same research group (Dattilo et al., 2012) showed in an animal model that sleep deprivation induces a catabolic hormone profile (enhanced plasma corticosteroids and reduced serum testosterone levels) leading to muscle atrophy. Studies in athletes also have demonstrated similar results, showing that sleep deprivation is associated with reductions in: muscle glycogen and sprint performance perceptual stress (Skein et al., 2011); exercise performance by decreasing exercise minute ventilation and time to exhaustion (Azboy and Kaygisiz, 2009); anaerobic performance (Souissi et al., 2008; Taheri and Arabameri, 2012); and with enhance sports-related overtraining and acute injuries (Luke et al., 2011). Those data cannot be directly extrapolated to the general population, but is reasonable to expect that some similar processes are occurring.

Finally, the stress-sleep-training response connection has potential implication for athletic performance and should be addressed by coaches and researchers. Symptoms of chronic stress, sleep disturbances, burnout, depression, anxiety, overtraining, and addiction are prevalent among athletes (Fietze et al., 2009; Lonsdale et al., 2009; Resch, 2010). Further, athletes showed poorer markers of sleep quality than a matched non-athletic control group (Leeder et al., 2012), and disrupted sleep and disturbed dreaming are common forms of sleep deprivation in athletes the night before important competitions (Bambaeichi et al., 2005; Erlacher et al.,

2011). For this reason, as previously pointed by other investigators (Lonsdale et al., 2009; Birrer and Morgan, 2010; Kristiansen and Roberts, 2010), we also believe that psychological skills training will be progressively more relevant in future athletic training, with a special focus on balancing self-determined motivation, psychological demands, skills and techniques, social support, and a good coach-athlete relationship in order to optimally enhance performance.

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