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ORIGINAL ARTICLE

Effects of two types of partial sleep deprivation on hematological responses during intermittent exercise: A pilot study

Effets de deux types de privation partielle de sommeil sur les réponses hématologiques pendant l'exercice intermittent : étude pilote

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Sleep deprivation;
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Summary
Objective. — To examine the effects of two types of partial sleep deprivation (PSD) on hematological responses at rest and following an intermittent exercise performed in the evening with young athletes.
Material and methods. — Ten Taekwondo players were randomized in three sleep conditions (baseline sleep night [BN], partial sleep deprivation at the beginning of night [PSDBN], partial sleep deprivation at the end of night [PSDEN]). Blood samples were collected during each condition, before and after a Yo-Yo intermittent recovery test level 1.
Results. — At rest and in comparison with BN, there was a significant decrease in monocytes ($P < 0.05$) after PSDEN; mean corpuscular hemoglobin concentration ($P < 0.001$) and mean corpuscular hemoglobin ($P < 0.001$) after PSDBN. However, a significant increase in red blood cell distribution width ($P < 0.01$) was observed after PSDBN. After exercise, PSD significantly decreased white blood cells ($P < 0.05$ in PSDBN; $P < 0.001$ in PSDEN) and lymphocytes ($P < 0.001$ in PSDBN and PSDEN). However, neutrophil counts decreased only in PSDEN ($P < 0.001$).

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Conclusion. — PSD at the beginning and at the end of night could cause an immunosuppression without alteration in red blood cells family, plasma iron and platelets family during the intermittent exercise.

MOTS CLÉS
Privation de sommeil ;
Exercice intermittent ;
Leucocytose ;
Immunodéficience ;
Taekwondo

Résumé
Objectif. — Étudier les effets de deux types de privation partielle de sommeil (PPS) sur les réponses hématologiques au repos et après un exercice intermittent réalisé le soir chez des jeunes athlètes.
Sujets et méthodes. — Dix athlètes de taekwondo ont été randomisés dans trois conditions de sommeil (nuit contrôle de sommeil normal [NSB], privation partielle de sommeil au début de la nuit [PPSDN], privation partielle de sommeil à la fin de la nuit [PPSFN]). Des prélèvements sanguins ont été effectués au cours de chaque condition, avant et après le Yo-Yo Intermittent Recovery Test niveau 1.
Résultas. — Au repos et en comparaison avec la NSB, il y a eu une diminution significative des monocytes ($p < 0{,}05$) après la PPSFN ; des concentrations corpusculaires moyennes en hémoglobine ($p < 0{,}001$) et des teneurs corpusculaires moyennes en hémoglobine ($p < 0{,}001$) après la PPSDN. Cependant, une augmentation significative de l'indice de distribution des globules rouges ($p < 0{,}01$) a été observée après la PPSDN. Après l'exercice, la PPS a significativement diminué le nombre des globules blancs ($p < 0{,}05$ pour la PPSDN ; $p < 0{,}001$ pour la PPSFN) et les lymphocytes ($p < 0{,}001$ pour la PPSDN et la PPSFN). Toutefois, les neutrophiles ont diminué seulement après la PPSFN ($p < 0{,}001$).
Conclusion. — Les PPS au début et à la fin de la nuit pourraient provoquer une immunosuppression, sans altération de la famille des globules rouges, du fer plasmatique et de la famille des plaquettes durant l'exercice intermittent.

1. Introduction

Sleep is commonly viewed as a restorative process [1] that influences the homeostatic regulation of the autonomic, neuroendocrine, and immune systems [2]. However, sleep loss induced by increased workload, shift work and various other challenges imposed by modern society may represent a serious threat for health and well being. Particularly, athletes who have to get up early to travel to a competition or who cannot fall asleep because of the stress of a major event may be experienced to sleep disturbances [3]. It has been shown that sleep loss can have deleterious consequences for the brain, for almost all bodily organs and systems [4] affecting thus its physiological and psychological functioning [5], as well as and especially, the evening physical performance, without nevertheless altering the morning performance, as has been recently revealed in our research group [3,6,7]. However, the physiological, biological, biomechanical and psychological mechanisms responsible of evening performance alteration are poorly understood at the moment.

Concerning the effects of sleep deprivation (SD) on biological responses (e.g., hematological), the results of previous studies remains unclear due to limited and conflicting evidence. While some research studies have shown that partial and total SD lead to increased white blood cells (WBC) and their subpopulations (i.e., neutrophils [NE], lymphocytes [LY], monocytes [MO]) [2,8–10], some other reported no effect of sleep loss [2,10] or a decrease in these parameters [9]. On the other hand, it seems that SD has no effect on hematocrit (HCT) [11] and red blood cells (RBC) [10].

Nevertheless, sleep loss is not the only factor to alter hematological responses. Indeed, acute exercise as a quantifiable model of physical stress has been shown also to affect hematological markers [12–15]. In this context, Gleeson et al. [12] showed that an acute exercise (a step test for 40 min) induced a significant leukocytosis and increased platelets (PLT) concentrations in healthy untrained subjects. More recently, our research group has found that high intensity exercises (repeated sprint ability and Wingate-tests) performed in the evening (5 pm) induced a significant increase in WBC and their main subpopulations (LY, NE and MO), as well as RBC counts and HCT levels in football players [15].

Concerning the concomitant effects of SD and exercise on hematological responses, only few studies have been conducted [14,16]. Plyley et al. [16] have shown that 64 h of total SD did not alter hematological parameters during maximal exercise. Moreover, Ricardo et al. [14] confirmed these findings after one night of SD during a sub-maximal and maximal exercise. However, unlike total SD, which has been extensively investigated experimentally, the effects of PSD have received less scientific attention. Indeed, Banks and Dinges [17] explained that PSD is a sleep restriction, that also referred to as sleep debt [18], which is characterized by reduced sleep duration and which alters sleep architecture but it does not affect all sleep stages equally. In this context, most previous studies analyzing the effect of PSD on sleep architecture established an eminent reduction