

Exercise, Immune System and Circadian Rhythm

Boukhemis Boukelia*

Edinburgh Napier University, United Kingdom

Abnormal circadian rhythms have been linked to illnesses such as diabetes, depression [1], bipolar disorder [2], seasonal affective disorder (SAD) [3] and even obesity [4]. Furthermore, circadian rhythms can affect body function and health due to sleep-wake cycles, body temperature [5], hormone release [6], and other important body functions. More recent studies have investigated other performance parameters that have also been found to possess a circadian rhythmicity, such as, stroke volume, cardiac output, blood pressure, vascular blood flow, metabolic rate, sweat rate and trunk flexibility [7].

The link between circadian rhythmicity and sport performance has been extensively studied with several contributing factors having been identified. These factors can be endogenous, including physiological changes such as core body temperature; and exogenous, including environmental changes such as sleep deprivation, and daily training time [5]. Identifying the cause for improved performance is often difficult because performance fluctuations can be affected by different exogenous and endogenous factors occurring at the same time of day.

The indirect evidence for the existence of circadian rhythmicity in sports performance can be examined by the time of day athletes perform best or worst in actual sporting events [8]. However, a great many sporting events are scheduled for the evening which may create a false circadian record. It is important therefore for coaches and athletes to be aware of how the time of day affects various and inter-related components of sport performance.

The circadian rhythm of the immune system and sport performance is still a new field of research, although it has been reported that circadian rhythmicity exists in the human immune system for some time [9,10]. Kimura et al. found that the circulation of the white blood cells involved in the defence of the human body show high-amplitude circadian rhythmicity: being lower in the morning and higher in the afternoon [11].

The immune system plays an important role in human health and the prevention of illness. In a review conducted by Gleeson et al. moderate exercise reduces the risk of chronic metabolic and cardiorespiratory diseases [12], in part because exercise exerts anti-inflammatory effects which is mediated through the reduction in visceral fat mass (adipokines decrease) and the induction of an anti-inflammatory environment with each bout of exercise. However, preventing athletes from illness during heavy training periods and/or races is a high priority for athletes, coaches and exercise researchers. A perception exists that some athletes, especially those engaging in prolonged intensive exercise and competition, such as running, cycling and swimming, may show an increased rate of upper respiratory tract infection (URTI) during intense training periods and competition [13]. Given the considerable economic and personal investment in preparing athletes for events, there is a need to identify strategies to improve host resistance whilst minimising the risk of illnesses that may affect athletic performance. An agreement between scientists exists in that moderate exercise enhances the athlete's immunity, but high-intensity prolonged exercise impairs, temporarily, immune competence. In addition, a relationship between immune-depression and risk of URTI has been established following heavy exercise [13].

The inverse relationship between exercise workloads and immune system function has been studied intensively [14]. A number of studies

have reported that exercise leads to a considerable physiological change in the human immune system [15]. However, immune suppression is higher in some athletes compared to general active population [14], while there does appear to be a secondary response in truly elite athletes which reverses this theory. Although modest exercise may enhance the function of the immune system above sedentary levels; prolonged high-intensity exercise can weaken the immune competence of trained athletes. It may be that this relationship is most likely affected by individual determinants such as circadian rhythmicity, dietary status, allergies or environmental conditions. An important finding of Boukelia et al., is that exercise in hot and humid conditions can allow for changes to the intensity of airway inflammation and is more effective in the evening were phase response for and recovery period of CC16 and white blood cells are high in the evening [16]. This finding may improve the treatment strategy in athletes suffering from upper airway dysfunction and could even be applied within an unhealthy population with a chronic disease such as asthma. This can be due to adaptive response rather than airway damage.

Athletes, coaches and event organisers can program their race events or training to target the time when athletes perform best and should consider the immunological and physiological parameters that can enhance performance.

References

1. Quera Salva MA, Hartley S, Barbot F, Alvarez JC, Lofaso F, et al. (2011) Circadian rhythms, melatonin and depression. *Curr Pharm Des* 17: 1459-1470.
2. Harvey AG (2008) Sleep and circadian rhythms in bipolar disorder: seeking synchrony, harmony, and regulation. *Am J Psychiatry* 165: 820-829.
3. Johansson C, Willeit M, Smedh C, Ekholm J, Paunio T, et al. (2003) Circadian clock-related polymorphisms in seasonal affective disorder and their relevance to diurnal preference. *Neuropsychopharmacology* 28: 734-739.
4. Kalra SP, Bagnasco M, Otukonyong EE, Dube MG, Kalra PS (2003) Rhythmic, reciprocal ghrelin and leptin signaling: new insight in the development of obesity. *Regul Pept* 111: 1-11.
5. Atkinson G, Todd C, Reilly T, Waterhouse J (2005) Diurnal variation in cycling performance: influence of warm-up. *J Sports Sci* 23: 321-329.
6. Czeisler CA, Klerman EB (1999) Circadian and sleep-dependent regulation of hormone release in humans. *Recent Prog Horm Res* 54: 97-130.
7. Atkinson G, Batterham AM, Kario K, Taylor CE, Jones H (2014) Blood pressure regulation VII. The "morning surge" in blood pressure: measurement issues and clinical significance. *Eur J Appl Physiol* 114: 521-529.
8. Drust B, Waterhouse J, Atkinson G, Edwards B and Reilly T (2005) Circadian rhythms in sports performance - An update. *Chronobiology International* 22: 21-44.
9. Miles MP, Andring JM, Pearson SD, Gordon LK, Kasper C, et al. (2008) Diurnal variation, response to eccentric exercise, and association of inflammatory

*Corresponding author: Dr Boukhemis Boukelia, Edinburgh Napier University, United Kingdom, Tel: +447988817717; E-mail: b.boukelia@gmail.com

Received July 15, 2015; Accepted August 08, 2015; Published August 19, 2015

Citation: Boukelia B (2015) Exercise, Immune System and Circadian Rhythm. *J Sports Med Doping Stud* 5: 163. doi:10.4172/2161-0673.1000163

Copyright: © 2015 Boukelia B. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

- mediators with muscle damage variables. *J Appl Physiol* 104: 451-458.
10. Shibata S and Tahara Y (2014) Circadian rhythm and exercise. *The journal of sport medicine and physical fitness* 3: 65-72.
 11. Kimura T, Inamizu T, Sekikawa K, Kakehashi M, Onari K (2009) Determinants of the daily rhythm of blood fluidity. *J Circadian Rhythms* 7: 7.
 12. Gleeson M, Bishop NC, Stensel DJ, Lindley MR, Mastana SS, et al. (2011) The anti-inflammatory effects of exercise: mechanisms and implications for the prevention and treatment of disease. *Nat Rev Immunol* 11: 607-615.
 13. Nieman DC, Henson DA, Austin MD, Sha W (2011) Upper respiratory tract infection is reduced in physically fit and active adults. *Br J Sports Med* 45: 987-992.
 14. Gleeson M, Bishop N, Oliveira M and Tauler P (2013) Influence of training load on upper respiratory tract infection incidence and antigen-stimulated cytokine production. *Scandinavian Journal of Medicine & Science in Sports* 23: 451-457.
 15. Walsh NP, Gleeson M, Shephard RJ, Woods JA, Bishop NC et al. (2011) Position Statement Part one: Immune function and exercise. *Exercise Immunology Review*. 17: 6-63.
 16. Boukelia B (2015) Diurnal variation in physiological, psychological and immune responses to running 10 km time trials performed in hot and cold environments. Unpublished PhD Thesis, Edinburgh Napier University.

This article was originally published in a special issue, entitled: "[Sport Medicine and Exercise Physiology](#)", Edited by Prof. Julien Baker, University of the West of Scotland, UK