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Letter to editor

Sleep/Wake Behaviours in Elite Athletes from Three Different Football Codes

Dear Editor-in-chief

Australian Rules football, rugby union and soccer are popular football codes played in Australia. Factors including physical contact, types of movement and rules of each sport influence the physiological demand placed on players (Varley et al., 2014). Differences in gameplay between the Australian Rules football, rugby union and soccer mean that their method of training may differ, potentially impacting the sleep/wake behaviour of football players.

During a match, Australian rules footballers cover more distance (~12.6 km) than rugby union (~6km) and soccer players (~10km) (Varley et al., 2014). Additionally, the degree of physical contact varies between the football codes. Australian Rules footballers are subjected to 13 high impact collisions on average per game (Varley et al., 2014). Rugby union players engage in between 54 and 105 high collisions per game (Coughlan et al., 2011), while soccer does not possess the physical contact present in Australian Rules Football and rugby union.

Differences can be observed between the movement patterns in Australian Rules football, rugby union and soccer. Australian Rules footballers are permitted to tackle and bump opponents from any direction during gameplay (Gray and Jenkins, 2010), meaning that dynamic movements are played on a 360 degree plane. Rugby union is played with a 'head to head' structure, with players engaging in repeated physical collisions combined with short bursts of high intensity efforts in a straight line (Varley et al., 2014). The open-style gameplay observed in soccer results in players changing direction every 5 s, and performing approximately 1300 different movement actions, including sprints, turns, tackles and jumps on a 360 degree plane (Iaia et al., 2009)

While the physiological demand varies between Australian Rules football, rugby union and soccer, it is unknown whether these demands and subsequent method of training influence athletes' sleep/wake behaviour. Therefore, the aim of the present study was to compare the sleep/wake behaviours of athletes from Australian Rules football, rugby union and soccer.

Fifty-one male athletes participated in this study (mean age ± SD, 27.3 ± 3.4 years). Athletes from Australian Rules football (n=16), rugby union (n = 28) and soccer (n = 7) were recruited from professional teams across Australia. Athletes were provided with written and verbal information regarding the purpose of the study and written informed consent was obtained.

The sleep/wake behaviours of all athletes were recorded for a minimum training period of seven nights. Participants completed a sleep diary and wore an activity monitor on their non-dominant wrist to objectively evaluate sleep/wake behaviours and timing of sleep periods (Actiwatch 64; Philips Respironics, Bend, Oregon, USA). Data were sampled in 1-min epochs, with a sensitivity of <40 counts per epoch to distinguish between sleep and wake states (Sargent et al., 2015). The following sleep related dependent variables were extracted from the activity monitors and sleep diary data:

- Bedtime: the self-reported clock time at which a participant went to bed to attempt to sleep.
- Get up time: the self-reported clock time at which a participant got out of bed and stopped attempting to sleep.
- Time in bed: the amount of time spent in bed attempting to sleep between bedtime and get-up time.
- Sleep onset latency: the period of time between bedtime and sleep start.
- Sleep duration: the amount of time spent in bed asleep.
- Wake during sleep: the amount of time (mins) spent awake between sleep start and sleep end
- Total sleep time: the sum of the sleep obtained at night and any sleep obtained the following day during a daytime nap (s).
- Movement and Fragmentation Index: an index of sleep quality based on the level of activity, and the number of transitions between mobility and immobility, within a sleep period. Higher scores indicate sleep of poorer quality
- Mean Activity Score: the sum of the activity counts between sleep onset and sleep offset divided by the number of epochs between sleep onset and sleep offset.

Separate one-way analyses of variance (ANOVA) were used to examine differences in sleep variables between the three football codes. Where required, Games-Howell post-hoc comparisons were used to determine statistical significance between variables. Statistical significance was set at $p < 0.05$.

On average, Australian Rules footballers went to bed earlier (22:55 ± 00:44h), compared to soccer (23:12 ± 00:44h) and rugby union players (23:36 ± 00:56h, $p < 0.05$). Australian Rules footballers got up earlier than (07:59 ± 01:18h), rugby union players (07:59 ± 01:25h) and soccer players (08:33 ± 01:51h, $p < 0.05$). There were no significant differences in total sleep time between Australian Rules footballers (6.8 ± 1.2h), rugby union players (7.2 ± 1.6h) and soccer players (6.7 ± 2h, $p > 0.05$). Post hoc comparisons revealed that Australian Rules footballers spent longer in bed, took longer to fall asleep (18 min vs. 10 min), spent more minutes awake sleep (70 min vs. 56-57 min) and recorded a higher amount of movement during sleep (90 min vs. 73-74 min), compared to soccer and rugby union players. Australian Rules footballers had the highest mean activity score (16 units vs. 14 units), compared to soccer and rugby union players (Figure 1).

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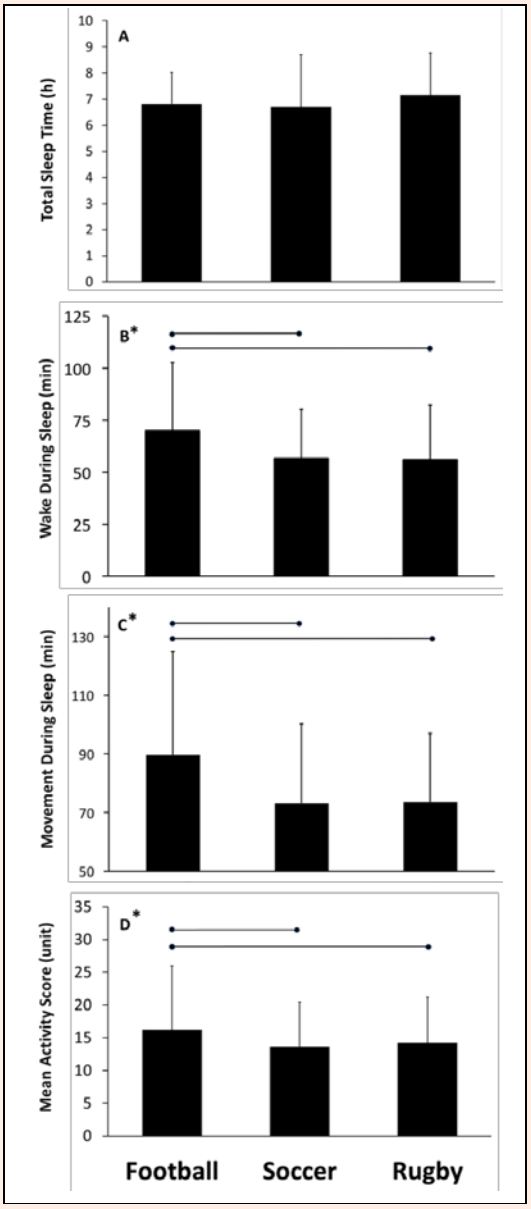

Figure 1. Total sleep time, wake during sleep, movement during sleep, and mean activity score for Australian footballers, soccer players and rugby players during a typical in-season training phase. Data are presented as mean and standard deviation. Asterisks identify significant main effect between groups. Horizontal lines with dots on either end indicate significant differences between football codes.

Overall, the main finding of this study is that Australian Rules footballers experienced more sleep disturbances, compared to rugby union players and soccer players. An explanation of these findings is that the high training demand of Australian Rules football may have resulted in increased pain and movement during sleep, therefore increasing sleep disturbances (Nicassio et al., 2012; Taylor et al., 1997). Since Australian Rules football is a considered to be a physiological hybrid of soccer and rugby union, it seems reasonable to suggest that the combination of high aerobic demand and high physical contact may explain the sleep disturbances observed in the current study. High training volumes has previously been shown to negatively impact sleep/wake behaviours in athletes (Nicassio et al., 2012; Taylor et al., 1997). Physiologically, high training and competition volume may increase pro-inflammatory cytokines, causing a rise in core body temperature and cortisol secretion; resulting in increased wakefulness (Cunniffe et al., 2010). Understanding athlete training demands is, therefore, imperative for prescribed training loads and injury management for athletes.

The lack of training data may be viewed as a potential limitation. However, the main focus of the study was to examine the sleep/wake behaviours of the athletes from different football codes. Further research is required to examine the combined impact of physical contact and aerobic exercise on the sleep/wake behaviours of football players. The present findings suggest that the way in which Australian Rules footballers train may result in increased sleep disturbances.

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References

Coughlan, G.F., Green, B.S., Pook, P.T., Toolan, E. and O'Connor, S.P. (2011) Physical game demands in elite rugby union: a global positioning system analysis and possible implications for rehabilitation. *Journal of Orthopaedic & Sports Physical Therapy* **41,** 600-605.

Cunniffe, B., Hore, A.J., Whitcombe, D.M., Jones, K.P., Baker, J.S. and Davies, B. (2010) Time course of changes in immuneoendocrine markers following an international rugby game. *European Journal of Applied Physiology* **108,** 113-122.

Gray, A.J. and Jenkins, D.G. (2010) Match analysis and the physiological demands of Australian football. *Sports Medicine* **40,** 347-360.

Iaia, F.M., Rampinini, E. and Bangsbo, J. (2009) High-intensity training in football. *International Journal of Sports Physiology and Performance* **4,** 291-306.

Nicassio, P.M., Ormseth, S.R., Kay, M., Custodio, M., Irwin, M.R., Olmstead, R. and Weisman, M.H. (2012) The contribution of pain and depression to self-reported sleep disturbance in patients with rheumatoid arthritis. *Pain* **153,** 107-112.

Sargent, C., Lastella, M., Halson, S.L. and Roach, G.D. (2015) The validity of activity monitors for measuring sleep in elite athletes. *Journal of Science and Medicine in Sport* **19,** 848-853.

Taylor, S.R., Rogers, G.G. and Driver, H.S. (1997) Effects of training volume on sleep, psychological, and selected physiological profiles of elite female swimmers. *Medicine & Science in Sports & Exercise* **29,** 688-693.

Varley, M.C., Gabbett, T. and Aughey, R.J. (2014) Activity profiles of professional soccer, rugby league and Australian football match play. *Journal of Sports Science* **32,** 1858-1866.

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