Team Performance, Players' Lifestyle Habits, and Circadian Phenotype in Professional Japanese Soccer Players (J League)

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Management of sleep and diurnal rhythm is important for professional athletes to maintain a competitive condition, especially for soccer players, who have a mixed schedule of morning practice and afternoon or evening games. This study aimed to identify differences in circadian phenotypes, sleep hygiene, and diurnal rhythms in soccer players according to stage (J1 or J2) and performance in the top Japanese league, the J League. We administered a questionnaire survey to 89 J League (J1 and J2) players younger than 26 years old (22.4 ± 2.1) utilizing scale of index on diurnal rhythm disturbance, which covers sleeping habits, breakfast time, and diet. Players were divided into four groups according to their ranking as of the July 2016 season—Group 1: 11 players from teams that ranked in the upper half of the J1 league; Group 2: 17 players from teams in the lower half of the J1 league; Group 3: 48 players from teams in the upper half of the J2 league; Group 4: 13 players from teams in the lower half of the J2 league. In a multiple comparison analysis, levels of sleep quality in Group 1 were higher than those in Group 2. Group 3 players showed significantly lower levels of disturbance of diurnal rhythm relative to those in Group 2. Well-regulated lifestyle habits that result in good quality sleep and less disruption in diurnal rhythms may increase competitiveness in professional soccer players.

Keywords: professional soccer players, sleep quality, circadian phenotype, team performance, risk of diurnal rhythm disturbance

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1. Introduction

Professional athletes are required to maintain a competitive condition to ensure success. In addition to proper training, lifestyle management is important for athletes' conditioning, which includes maintaining a good sleep pattern and proper diurnal rhythms. However, these can be disturbed easily by psychological stress associated with competition, morning training, night games, and long-distance travel to game locations. Therefore, many studies have examined the effects of sleep and diurnal rhythm on athletes' performance. According to Fullagar et al. (2015), many studies have reported that sleep loss resulted in a subsequent decline in exercise capacity and cognitive performance. Moreover, sleep disturbance could increase the risk of injury for athletes. Murdaugh et al. (2018) reported that the continued presence of low sleep quantity and sleep disturbance in young athletes with sports-related concussions increased the risk of protracted recovery. Therefore, despite increasing awareness that sleep loss affects athletes' health and performance, this knowledge is not yet fully utilised in the management of their conditioning. In a review, Chennaoui et al. (2015) stated that sleep was often mismanaged in sportsmen, with pejorative consequences for cognitive performance, effort perception, and exercise-induced disease. In addition, Mah et al. (2018) reported that numerous college athletes experienced poor sleep quality, regularly failed to achieve sufficient sleep, and exhibited daytime sleepiness. Further, some studies have reported that proper sleep hygiene management improves athletes' performance. For example, Mah et al. (2011) reported that the extension of sleep duration improved sports performance in college basketball players.

Moreover, numerous studies have been conducted to examine sleep health in soccer players. Fowler et al. (2017) showed that sleep disruption associated with long-haul transmeridian air travel reduced soccer players' wellness. Nédélec et al. (2015) pointed out in a review paper that professional soccer players experience many risks to their sleep hygiene and that sleep deprivation can lead to injury or mental fatigue.

Several important findings have also been revealed regarding relationships between physical conditioning and circadian phases. In a review, Facer-Childs and Brandstaetter (2015) found that circadian rhythm regulates key physiological processes involved in athletic performance. In addition, Smith et al. (2013) showed that playing close to the circadian peak in performance results in athletic advantage. Therefore, the circadian peak should coincide with main game time to ensure best performance in a game. While, Facer-Child and Brandstaetter (2015) showed that peak performance times in athletes differed between human 'morning larks' and 'night owls' (i.e., people who prefer waking early and those who prefer waking late, respectively), with earlier peaks in morning larks and later peaks in night owls. Therefore, diurnal rhythm matching of the circadian peak to game time is important to improve athletes' performance.

As mentioned above, numerous studies have examined the relationship between sleep or diurnal rhythm and sports performance. It is known that circadian system synchronicity is necessary for good sleep quality. Regular sleeping habits and breakfast consumption result in circadian system synchronicity. These lifestyle habits are similarly effective for maintaining a not-evening circadian phenotype, and this knowledge has been incorporated into sleep education (Tanaka and Tamura, 2016). The human circadian clock system consists of the main clock of the suprachiasmatic nucleus and the peripheral clocks of the whole body. The zeitgeber of the main clock is only the light environment, and while the peripheral clocks entrain to the main clock, the phase of the peripheral clocks is also changed by other zeitgebers, such as the timing of food or nutrient status. In particular, dietary habits are a very important zeitgeber in appetite and metabolic rhythms, and disordered dietary habits are known to impair the synchrony of the entire circadian system. Regarding eating habits, it is known that the timing and contents of breakfast are important in synchronising the metabolic clock of the liver (Oda, 2015). Therefore, professional athletes should adjust their lifestyles carefully based on diurnal rhythm, including circadian system synchronicity and sleep hygiene. However, no studies have been conducted to examine the relationships among sleeping habits, diurnal rhythms, dietary habits (especially relating to breakfast), and performance in professional soccer players. Therefore, the primary purpose of the current study was to examine the differences in circadian phenotypes and sleep hygiene in players, depending on the stage and results in the top Japanese professional league, the J League. The secondary purpose of the study was to examine overall diurnal rhythms, sleep hygiene, and lifestyle, such as dietary habits, all of which can greatly affect synchrony of the circadian system, and determine whether they differed according to stage (J1 or J2) and results in this league. The results of this study may provide material to inform consideration of the relationship between soccer team performance and players' lifestyle management, which would be helpful for professional soccer players in managing their conditioning.

2. Methods

2.1. Participants

In total, 237 soccer players from 11 J League teams participated in the questionnaire survey (48, 145, and 44 from J1, J2, and J3, respectively). The J League (J1 and J2) players were divided to four groups: J1 league players from teams that ranked in the upper half of the league (Group 1), J1 league players from teams that ranked in the lower half of the league (Group 2), J2 league players from teams that ranked in the upper half of the league (Group 3), and J2 league players from teams that ranked in the lower half of the league in the July 2016 season (Group 4). Human body functions change with age, including sleep duration and quality (Roffwarg et al., 1966) and circadian phenotype (Foster and Roenneberg, 2008) . As all players in Group 1 were younger than

26 years old, we analysed data for 89 players (11 in Group 1, 17 in Group 2, 48 in Group 3, and 13 in Group 4) in this age group (mean age: 22.4 ± 2.1). J3 league players were not included in the subsequent survey because membership requirements for the J3 league are less stringent than those for the J1 and J2 leagues, and there are large differences between teams according to players' status, including training hours, available facilities, and economic conditions.

2.2. Procedure

The participants completed an integrated questionnaire (Harada et al., 1998) (**Appendix 1**), which consisted of the Diurnal Type Scale (Torsvall and Åkerstedt, 1980) , questions pertaining to sleeping habits (bedtime, waking time, and sleep duration), breakfast time, and diet, and questions about primary training schedule (start timing and end timing). Diurnal Type Scale scores range from 7 to 28, with lower scores indicating an evening diurnal type and higher scores indicating a morning diurnal type. The use of Diurnal Type Scale score can reduce the burden on respondents because, unlike other major scales, it consists of only seven items and is well-balanced with questions about morning phase points and about night phase points. According to Monroe's definition (Monroe, 1967), sleep quality was scored on a scale of 3–9 using the following three items: ease of falling asleep (always good–always bad), sleep latency (less than 10 minutes–more than 30 minutes), and night awakening (no–at least once a night). Using these questions, a risk index for diurnal rhythm disturbance was used for the first time in this study to signify the intensity of disturbance in 24-hour variation of physiological functions and sleep hygiene (**Table 1**). **Table 1** shows the answers gained to the questionnaire items. This index consisted of eight components for each of which participants could choose a response of either Risk (1 point) or No Risk (0 points). Total scores ranged from 0 to 8, and higher scores indicated greater risk of the evening diurnal type with greater social jet lag and worse sleep hygiene.

Comparison of Diurnal Type Scale scores, sleeping habits, eating habits, and risk index values between groups was performed using the Kruskal–Wallis test for continuous variables and Fisher's exact test for

Table 1 Risk index on the diurnal rhythm disturbance (0-8 points)

	Components of Risk index	**Risk (1 point)**	**No risk (0 point)**
1	The Diurnal Type Scale scores	Evening-typed (lower scores occupying 25%)	Morning- and Medium typed (the other 75%)
2	Sleep duration on weekdays	< 8 hours (shorter hours occupying 25%)	8 and >8 hours (longer hours occupying 75%)
3	Regularity of bedtime	> 1 hour as the difference between weekdays and weekends (upper 25%)	< 1 hour as the difference between weekdays and weekends (lower 75%)
4	Regularity of wake time	>1.5 h as the difference between weekdays and weekends (upper 25%)	< 1.5 h as the difference between weekdays and weekends (lower 75%)
5	Regularity of sleep hours	>1h as the difference between weekdays and weekdays (upper 25%)	<1h as the difference between weekdays and weekends (lower 75%)
6	Quality of sleep (Monroe-index) (Monroe, 1967)	Lower quality of sleep	Higher quality of sleep
7	Regularity of breakfast timing	Irregular	Regular
8	Nutritionally rich	< 4 times per week	More than 4 times per week

categorical variables. The statistical analysis was performed using SPSS Statistics ver. 24 (IBM corp.). A Steel–Dwass test was performed using R2.8.1 for post hoc multiple comparison.

3. Results

There was no significant difference in age between the four groups included in the study (Kruskal–Wallis test, χ^2- value = 6.34, df = 3, p = .096). On their primary training schedule, 97.7% of players said they start training by 10 am and 96.5% said they finish by 1 pm.

Participants' Diurnal Type Scale scores ranged from 9 to 27, with a mean score of 17.4 ± 3.5 (**Figure 1**).

Average values for bedtime, waking time, and sleep duration on weekdays were 22:49±0:42, 07:10±0:40, and 8.34±0:44 hours, respectively. The proportions of J League players for whom differences of more than 1 hour in bedtimes, waking times, and sleep durations were observed between weekdays and weekends were 25.0%, 23.9%, and 23.9%, respectively. The proportion of J League players who reported lower sleep quality was 4.6%.

There was no significant difference in Diurnal Type Scale scores (Kruskal–Wallis test: χ^2 = 7.48, df = 3, p = .058; **Figure 1**) (Mean±SD: Group 1= 16.4±2.2, Group 2 = 16.6±3.0, Group 3 = 18.6±3.6, Group 4=16.2±4.4) or sleeping hours (Kruskal–Wallis test: χ^2 = 4.48, df = 3, p = .214; **Figure 2**) (Mean±SD: Group 1 = 8.0±0.4, Group 2 = 8.2±0.7, Group 3 =

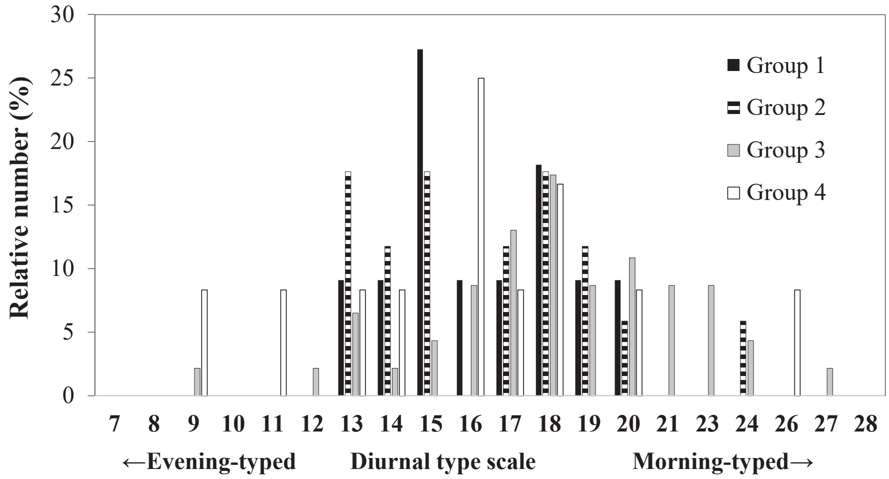

Figure 1 Diurnal type scale scores of professional soccer players in J League (Kruskal-Wallis test: χ^2 = 7.48, df = 3, p= .058)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

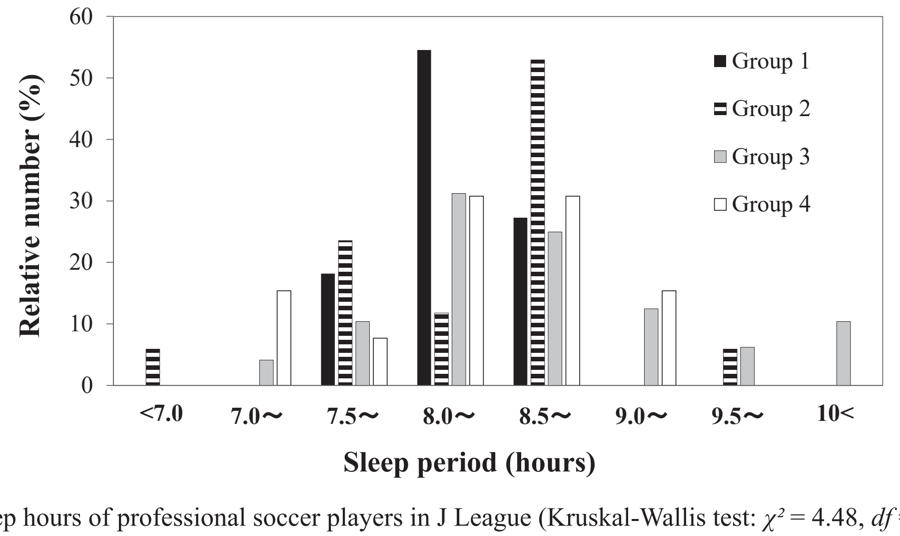

Figure 2 Sleep hours of professional soccer players in J League (Kruskal-Wallis test: χ^2 = 4.48, df = 3, p = .214)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

8.5±0.8, Group 4 = 8.1±0.6) among the four groups. There were also no significant differences in gap between weekday and weekend bedtimes (Kruskal–Wallis test: χ^2 = 3.49, *df* = 3, *p* = .322; **Figure 3**) (Mean±SD: Group 1 = 0.6±0.6, Group 2 = 1.0±0.9, Group 3 = 0.8±0.7, Group4 = 1.0±0.5), gap in waking times (Kruskal–Wallis test: χ^2 = 5.13, *df* = 3, *p* = .162; **Figure 4**) (Mean±SD: Group 1 = 0.9±1.0, Group 2 = 1.5±1.4, Group 3 = 0.9±0.9, Group 4 = 1.4±0.8), or gap in sleep duration (Kruskal–Wallis test: χ^2 = 4.44, *df* = 3, *p* = .217; **Figure 5**) (Mean±SD: Group 1 = 0.7±0.9, Group 2 = 1.1±0.9, Group 3 = 0.7±0.7, Group 4 = 0.8±0.6) among the four groups.

There were no significant differences in the regularity of breakfast time (Fisher's exact test: *p* = .666; **Figure 6**) (percentage of players who have breakfast at a regular time every day: Group 1 = 36.4%, Group 2 = 35.3%, Group 3 = 60.4%, Group 4 = 30.8%) or the frequency with which a nutritionally rich breakfast was consumed (more than four times per week: Fisher's exact test:, *p* = 1.000; **Figure 7**) (percentage of players who have a well-balanced breakfast every day: Group 1 = 27.3%, Group 2 = 29.4%, Group 3 = 44.7%, Group 4 = 46.2%) between Group 1 and each of the other three groups. There was a significant difference in sleep quality, evaluated using Monroe's score (1967), among the four groups (Kruskal–Wallis test: χ^2 = 10.10, *df* = 3, *p* = .017;

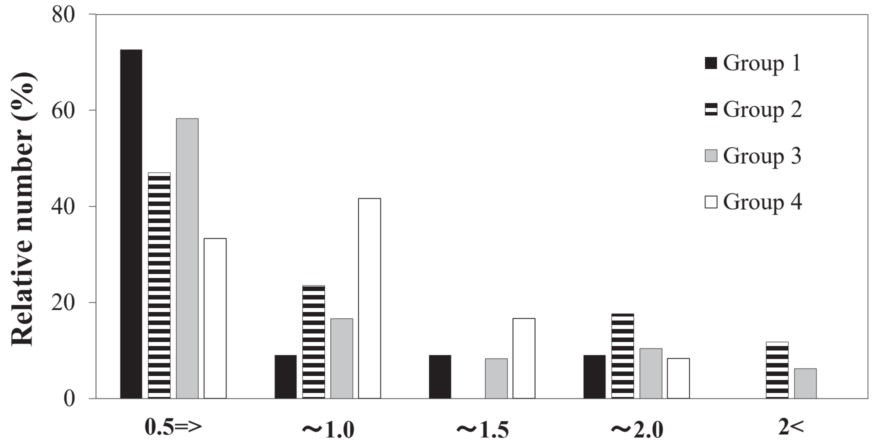

Figure 3 Bedtimedifference between weekdays and weekends of professional soccer players in J League (Kruskal-Wallis test: χ^2 = 3.49, *df* = 3, *p* = .322)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

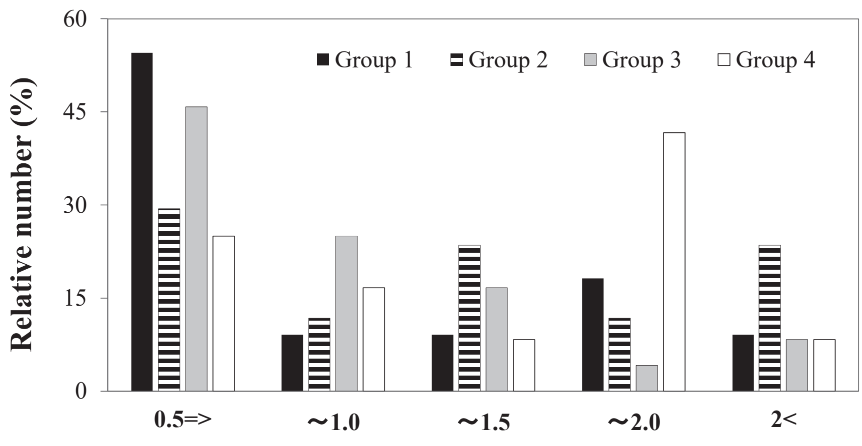

Figure 4 Wake-up time difference between weekdays and weekends night of professional soccer players in J League (Kruskal-Wallis test: χ^2 = 5.13, *df* = 3, *p* = .162)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

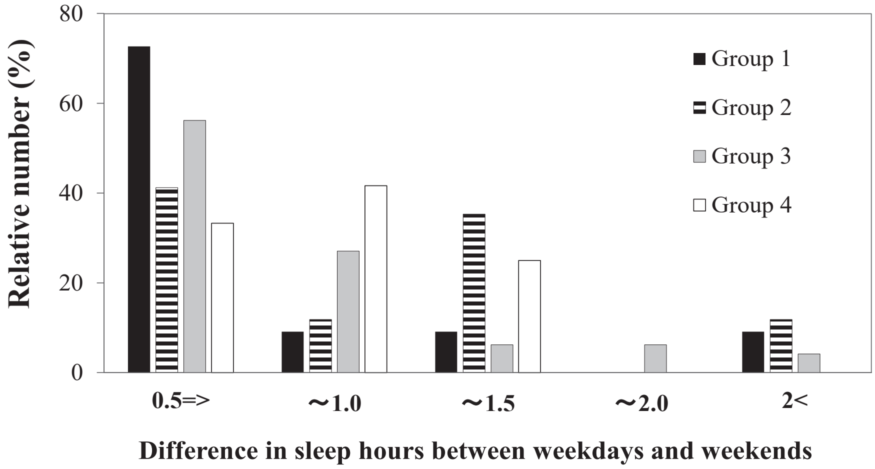

Figure 5 Sleep period difference between holiday night and weekday night of professional soccer players in J League (Kruskal-Wallis test: χ^2 =4. 44, df = 3, p = .217)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

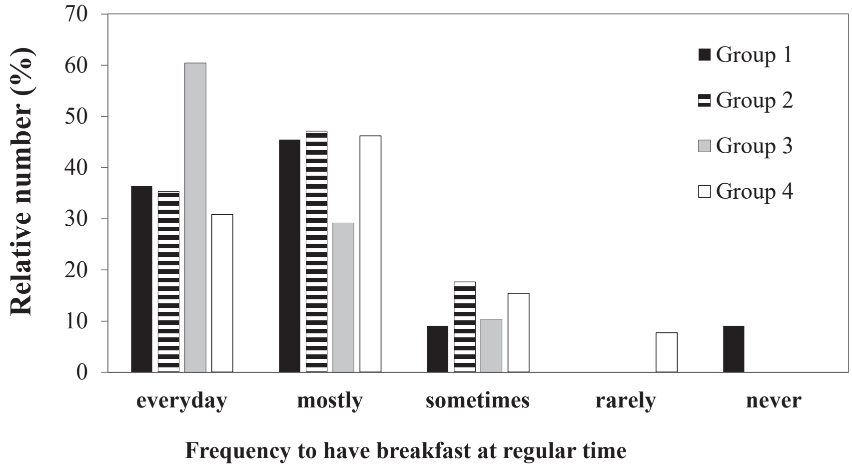

Figure 6 Frequency to have breakfast at regular time in J League professional soccer players (Fisher's exact test: p = .666, top half players in J1 and the others)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

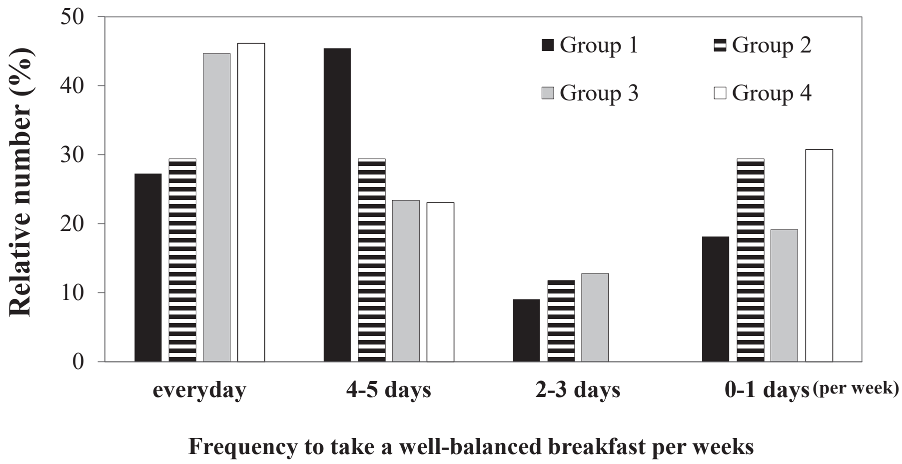

Figure 7 Frequency to take the well-balanced breakfast per weeks in J League professional soccer players (Fisher's exact test: p = 1.000, top half players in J1 and the others)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

Figure 8). The results of the multiple comparison showed that sleep quality in Group 1 was significantly higher relative to that in Group 2 (Steel–Dwass test: t = 3.0, p = .013; **Table 2**). With respect to the index value of diurnal rhythm disturbance (range: 0–8 scores; **Table 1**), the results of the Kruskal–Wallis test showed a significant difference among the four groups (χ^2 = 9.72, df = 3, p = .021; **Figure 9**). In addition, Group 3 players showed significantly lower levels of disturbances relative to those observed in Group 2 (Steel–Dwass test, t = 2.7, p = .034; **Table 3**).

4. Discussion

Top professional soccer players (J1 league players in teams that ranked in the upper half of the league) reported high levels of sleep quality. Although there was no significant difference between groups 1, 3, and 4, likely due to the small sample size in the study, Group 1 (4.4) seemed to have the highest sleep quality, followed by Group 3 (5.4) and Group 4 (5.6). Therefore, a significant difference in risk scores between players in the upper half of the top league and others could potentially be observed in research with larger sample sizes. Reduction in sleep quality

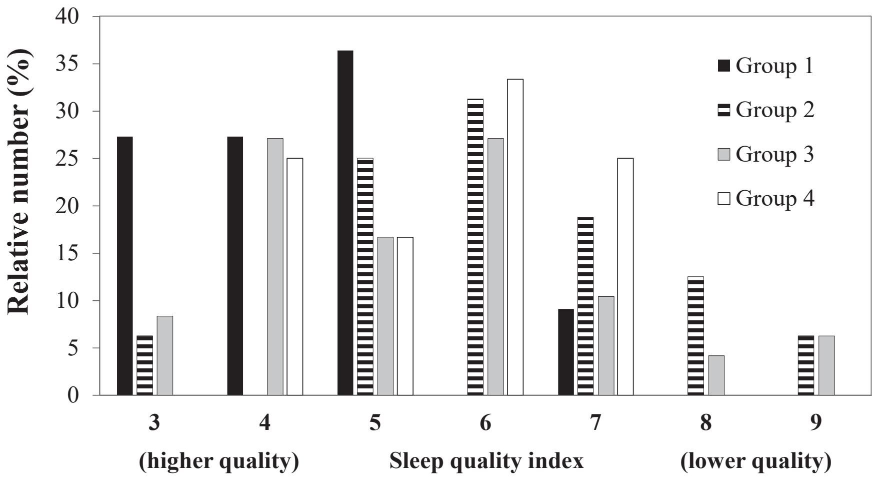

Figure 8 Sleep quality of professional soccer players in J League (Kruskal-Wallis test: χ^2 = 10.10, df = 3, p = .017 among several ranks of top half J1, bottom half J1, J2 and J3) (Monroe, 1960)
Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

Table 2 Multiple comparison analysis of sleep quality index (3-9; The lower the value, the better the quality of sleep) by team performance and J league stage

			Group 1	Group 2	Group 3	Group 4
Distribution	mean		4.4	6.2	5.4	5.6
	SD		1.2	1.5	1.7	1.2
	percentile	25	3.0	5.0	4.0	4.3
		50	4.0	6.0	5.0	6.0
		75	5.0	7.0	6.0	6.8
Steel-Dwass test	Group1 vs	t	-	3.0	2.0	2.2
		p		.013	.187	.122
	Group 2 vs	t	-	-	1.8	1.1
		p			.260	.706
	Group 3 vs	t	-	-	-	0.6
		p				.924

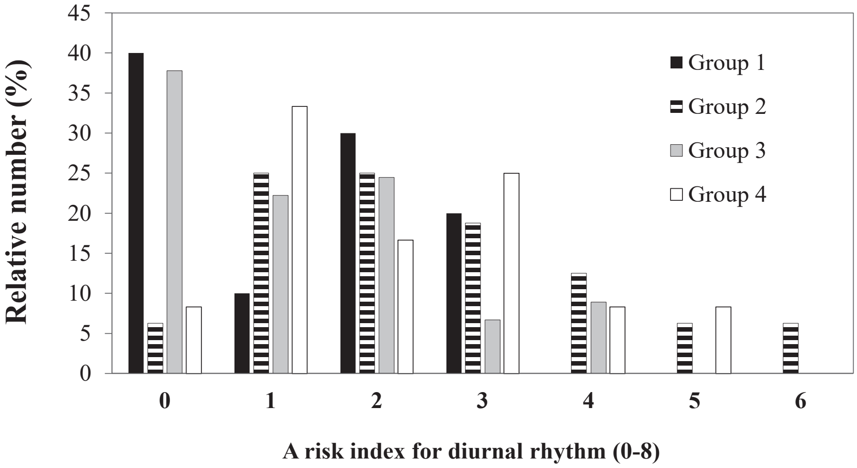

Figure 9 A risk index for diurnal rhythm in J League professional soccer players (Kruskal-Wallis test: $\chi^2 = 9.72$, $df = 3$, $p = 0.021$) Group 1: J1 (top half), Group 2: J1 (bottom half), Group 3: J2 (top half), Group 4: J2 (bottom half)

Table 3 Multiple comparison analysis of the Diurnal Health risk scores (0-8; The smaller the value, the less risk of disturbing the diurnal rhythm and sleep hygiene) by team performance and J league stage

			Group 1	Group 2	Group 3	Group 4
Distribution	mean		1.3	2.5	1.3	2.2
	SD		1.3	1.6	1.3	1.5
	percentile	25	0	1.0	0	1.0
		50	1.5	2.0	1.0	2.0
		75	2.3	3.8	2.0	3.0
Steel-Dwass test	Group 1 vs	*t*	-	1.80	0.20	1.40
		p		.285	.998	.531
	Group 2 vs	*t*	-	-	2.7	0.5
		p			.034	.959
	Group 3 vs	*t*	-	-	-	2.0
		p				.196

could disturb the balance of the autonomic nervous system and immune system and lead to declines in cognitive function (Fullagar et al, 2015). Moreover, high-quality sleep is believed to include both high-quality and sufficient REM sleep and to promote rest of sensory and motor components and better memory consolidation (Goerke et al., 2013; Wiesner et al., 2015), including in relation to soccer performance. In addition, there is a bidirectional association between sleep efficiency and mental toughness (Brand et al, 2014), which is related to players' performance (Newland et al., 2013). Therefore, better sleep quality is important for athletes' physical or technical competitiveness and mental toughness, and in top professional soccer players, could lead to team victory.

There were no significant differences in any other variables (that is, sleep duration, the regularity of sleeping habits, or breakfast consumption), with the exception of risk index values for diurnal rhythm disturbance, among the four groups. The reason for this finding could be that the J1 and J2 teams have dormitories for young players, minimising disruption to their regimen. Alternatively, this finding could have occurred because of the small sample size in the study. The proportion of J1 and J2 players who did not skip breakfast was 77.0%, which is higher than the value reported for student athletes (approximately 40% to 60%; Takebe et al., 2008; Azuma et al., 2010). Although there was no significant difference among groups, the players in the upper half of the league tended to be at less risk of irregular sleeping habits than those in the lower half of the league (**Appendix 2**).

Group 3 (upper half of J2 league) players showed lower risk of diurnal rhythm disturbance than Group 2 (lower half of J1 league) players. Group 3 players could be considered more competitive than Group 2 players, given their ranking at each stage. Although there was no significant difference among groups because of the small sample size in the study, Group 1 (40.0%) contained the highest proportion of players at no risk of disruption to their diurnal rhythms, followed by Group 3 (37.8%), Group 4 (8.3%), and Group 2 (6.3%; **Figure 8**, **Appendix 2**). Therefore, a significant difference in risk scores between players in the upper half of the league and those in the lower half of the league could be observed in research with larger sample sizes. A risk-free lifestyle provides sufficient high-quality sleep, which increases players’ competitiveness (Tanaka and Tamura, 2016). This type of lifestyle also prevents the development of an evening diurnal type and provides synchronised daily variation of physiological functions (Tanaka and Tamura, 2016; Morris et al, 2012). Therefore, regular lifestyle habits that maintain a morning diurnal type could increase professional soccer players’ competitiveness and improve teams’ success rates.

This study was subject to several limitations. For example, it was not possible to draw a direct conclusion about causality from the results, as the study was cross-sectional in nature. Although the players in the teams with better performance reported high levels of sleep quality, it was not possible to conclude that players’ sleep quality led to team success. In addition, we included team performance as a dependent variable and did not objectively measure player performance, despite differences in competitiveness between players on a given team. Moreover, because it is strategically important information for team management and hence confidential, we could not obtain data regarding players’ individual participation times in official games. Future studies should examine the effects of diurnal rhythms and sleep hygiene on the performance of professional athletes based on objective evaluations using intervention surveys.

5. Conclusion

Although it was conducted with a small sample size, this study demonstrated that professional soccer players in high-ranking teams showed better sleep quality and less risk of disruption of diurnal rhythms relative to players in low-ranking teams. Moreover, well-regulated lifestyle habits resulting in high synchronicity of the circadian system and high-quality sleep could be advantageous for highly competitive professional soccer players. These results are consistent with previous basic studies on the synchronisation and diurnal performance of the human circadian clock mechanism. It would be desirable to collect evidence from a larger sample and use such data to reflect on professional athlete lifestyle education.

Conflict on this research

There are no conflicts of interest in relation to this research.

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Main Works:

- Kawamata, M., Takeuchi, H., Kimura, N., Kawada, T., Milada, K., Taniwaki, N., and Harada, T. (2020).Relationship between burnout and circadian typology and sleep habits in Japanese nursery school and kindergarten teachers.Biological Rhythm Research, 51: 29-39.
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Membership in Learned Societies:

- Japanese Society of Science and Football
- The Japan Society of Coaching Studies
- Japan Society of Physical Education, Health and Sport Sciences
- Japanese Society for Chronobiology

Appendix 1

Lifestyle Questionnaire (Harada et al., 1998)

<table>
<tr><td colspan="2">Gender:
Male / Female</td><td colspan="2">Date of Birth: DD/MM/YYYY</td><td>Age:</td></tr>
<tr><td colspan="3">Hight (cm):
(cm)</td><td colspan="2">Weight (kg):
(kg)</td></tr>
</table>

QUESTIONNAIRE ON LIFE RHYTHMS AND SLEEP HABITS

● **Instructions**

- Please, answer the questions on your life habits during the last month.
- Please, answer the questions in order: do not be back and forth among questions.
- Please, answer the questions as they are. Answers to the questionnaire will be used only for academic use. You have not to write down your own individual name on the questionnaire.
- Because this is not an examination, please, feel it easy!

1. In weekdays, what time do you go to bed?

   On average:___________:_____________ (e.g. 23:30)

2. In weekdays, how many minutes do you need to fall asleep?

   (1) 0-5 min, (2) 6-15 min, (3) 16-30min,
   (4) 31-45 min, (5) 46-60min, (6)more than 1 hour

3. In weekdays how often do you feel difficulty to fall asleep?

   always □often □sometimes □occasionally □never

4. In weekdays, what time are you awoken?

   On average_____________:_____________ (e.g. 06:30)

5. In weekdays, how long do you stay in bed after awoken ?

   (1) 0-5min, (2) 6-15min, (3) 16-30min,
   (4) 31-45min, (5) 46-60min, (6) more than 1 hour

6. In weekdays, do you feel difficulty to get up in the morning?
(1) always, (2) often, (3) sometimes, (4) occasionally, (5) never

7. In weekdays, how many times do you usually wake up in the night?
(1) never, (2)once, (3) two times, (4) three times, (5) more than three times

8. In the weekend, what time do you go to bed?
On average:__________:__________ (e.g. 23:30)

9. In the weekend, how many minutes do you need to fall asleep?
(1) 0-5min, (2) 6-15min, (3) 16-30min,
(4) 31-45min, (5) 46-60min, (6) more than 1 hour

10. In the weekend, how often do you feel difficulty to fall asleep?
(1) always, (2) often, (3) sometimes, (4) occasionally, (5) never

11. In the weekend, what time are you awoken?
On average__________:__________ (e.g. 06:30)

12. At the weekend, how long do you stay in bed after awoken?
(1) 0-5min, (2) 6-15min, (3) 16-30min,
(4) 31-45min, (5) 46-60min, (6) more than 1 hour

13. At the weekend, do you feel difficulty to get up in the morning?
(1) always, (2) often, (3) sometimes, (4) occasionally, (5) never

14. In the weekend, how many times do you usually wake up in the night?
(1) never, (2)once, (3) two times, (4) three times, (5) more than three times

15. When would you prefer to rise (provided you have a full day's study-8h) if you were totally free to arrange your time ?
(4) before 06:30, (3) 06:30-07:29, (2) 07:30-08:29, (1) 08:30 or later

16. When would you prefer to go to bed (provided you have a full day's study-8h) if you were totally free to arrange your time?

(4) before 21:00, (3) 21:00-21:59, (2) 22:00-22:59, (1) 23:00 or later

17. If you always had to go to bed at 21:00, what do you think it would be like to fall asleep then ?
    (4) easy – would fall asleep practically at once,
    (3) rather easy – would lie awake for a short while,
    (2) rather difficult – would lie awake for some time,
    (1) very difficult – would lie awake for a long time

18. If always you had to rise at 06:00, what do you think it would be like to get up then ?
    (4) easy – no problem at all (3) a little unpleasant but not great problem
    (2) rather difficult and unpleasan (1) very difficult and unpleasant

19. When do you usually begin to feel the first signs of tiredness and need for sleep?
    (4) before 21:00, (3) 21:00-21:59, (2) 22:00-22:59, (1) 23:00 or later

20. How long a time does it usually take before you "recover your faculties" in the morning after rising from a night's sleep?
    (4) 1-10 min., (3) 11-20 min, (2) 21-40 min, (1) more than 40 min

21. Please, indicate to what extent you are a morning or evening active individual.
    (4) pronounced morning active (morning alert and evening tired)
    (3) to some extent morning active
    (2) to some extent evening active
    (1) pronounced evening active (morning tired and evening alert)

22. How frequently do you have meals at regular time ?

-Breakfast

(1) every day (2) mostly (3) sometimes
(4) irregular time (5) I don't take breakfast

-Lunch

(1) every day (2) mostly (3) sometimes
(4) irregular time (5) I don't take lunch

-Dinner

(1) every day (2) mostly (3) sometimes

(4) irregular time (5) I don’t take dinner

-Snack (morning snack, afternoon snack, midnight meal)

(1) ________________times / day, ______________days / week

(When do you usually eat snacks? _____________:_____________)

(2) I don’t eat snacks.

23. Please answer the question only when you select one of (1)-(3) in the previous question “22”.

What time do you take meals? (e.g. 07:30 for breakfast, 20:00 for dinner)

-Breakfast ___________:___________

-Lunch ___________:___________

-Dinner ___________:___________

How often do you usually have a breakfast? _____________________days / week

24. Please answer the question, only when you selected one of (1)-(4) of breakfast in question “22”. All the menus included in your usual breakfast would you check among the following? If you check (11), (12), (19), (26), please describe the detailed in ( ) (e.g. beef, mackerel, dried salmon, banana etc.)?

(1) rice, (2) bread or dumplings, (3) noodles,

(4) potatoes, (5) serials, (6) eggs,

(7) fermented soybeans = “Natto”, (8) “Tofu” made from soybeans,

(9) soybeans milk, (10) meats [including ham, bacon, sausage],

(11) fishes ( ), (12) dried fishes ( ),

(13) milk, (14) products from milk (e.g. yogurt, cheese),

(15) lactic acid (bacteria) beverage,

(16) vegetables with apparent colors as reds, orange etc.,

(17) the other vegetables, (18) 100% vegetables juices,

(19) fruits ( ), (20) 100% fruits juices,

(21) 100% fruits & vegetables mixture juices, (22) coffee,

(23) tea, (24) green tea, (25) other kinds of "juices",

(26) nutritional supplements ( )

25. Please answer the question, only when you selected one of (1)-(4) of breakfast in question "22". How many times do you take the well-balanced breakfast which consists of three components of carbohydrates (rice, bread, potatoes, noodles, dumplings etc.), proteins (meats, fishes or eggs, +soybeans), and vitamins and minerals (vegetables or seaweed)?

(1) everyday (2) 4-5 times per week (3) 2-3 times (4) 0-1 time

26. What time do you usually start and end training?

Start time ______ : ______, End time ______ : ______

Appendix 2

Table Percentage of no risk players for each item of the risk index for diurnal rhythm

	J1 league		J2 league	
	Group 1	Group 2	Group 3	Group 4
1 The Diurnal Type Scale scores	54.5	52.9	82.6	66.7
2 Sleep duration on weekdays	81.8	70.6	85.4	76.9
3 Regularity of bedtime	81.8	70.6	75.0	75.0
4 Regularity of wake time	63.6	41.2	70.8	41.7
5 Regularity of sleep hours	81.8	52.9	83.3	75.0
6 Quality of sleep (Monroe-index) (Monroe, 1967)	100.0	93.8	93.8	100.0
7 Regularity of breakfast timing	81.8	82.4	89.6	76.9
8 Nutritionally rich	72.7	58.8	68.1	69.2
No risk for all items	40.0	6.3	37.8	8.3