Our body clock

How to use it to train and compete

Circadian rhythms are biological processes that involve built in and self-sustaining rhythms that are adjusted by the local environment.

> *"People whose circadian rhythms are synchronized to their local environment and wake habitually at 8 am would be expected to have their lowest body temperature occur [in the morning] and their peak body temperature occur [in the evening]. If the difference between the maximum and minimum of peak sport performance is assumed to be 1 percent, then elite male runners would be two seconds faster in a 1500 meter run and 75 seconds faster in a marathon run [in the evening] compared [to the morning] due to this assumed circadian variation in performance."*
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> —Federation International de Medicine Du Sport (2004)

As a coach, I strive to leave nothing to chance in the preparation of an individual athlete or team for a major championship. From my perspective and experience, greatness is embedded in the details of these preparations. With this focus in mind in this Slowinski at-large, I explore from both a training and competition standpoint how the time of day impacts your body's ability to maximize performance.

To start, your circadian rhythm will vary throughout the day. Being aware of what your circadian rhythm is will impact your decision making about training times and how you warm-up for competition as well as determine the time of day you will practice for a tournament.

Research about circadian rhythms and performance

An individual's body temperature slowly increases throughout the day with the minimum

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at 0600 and the maximum at approximately 1800 hours, cooling again throughout the evening. Due to body temperature variation throughout the day of around 1.4 degrees Fahrenheit (0.8 Celsius), flexibility in the morning is reduced while maximized in the early evening.

To illustrate, a study by Gifford (1987) found an average variation of 13.12 degrees in lumbar flexion (lower spine) over a 24 hour testing period. In a fingertip to floor test, the average variation was 14.4 centimeters (5.66 inches). There was no variation in the flexibility associated with lateral movement of the spine throughout the day.

With such variation in body temperature and flexibility, sport performance is significantly different naturally throughout the day. By selecting to perform at your peak time, a performance level can increase by at least ten percent (Manfredini et al.1998). Placing this in the context of a performance perspective, a ten percent decline in performance is equivalent to competing after getting less than three hours of sleep or drinking the legal limit of alcohol.

> *"This impact makes an understanding of the circadian variation in sports performance an important practical consideration for both athletes and coaches in competition and might have important implications for both the short- and long-term success of an athlete or team. There is also an impact on athletic training, where the motivational climate of competitive stress is absent, and the training stimulus is highly dependent on the athlete's input of effort."*
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> *(Drust et al. 2005)*

A study of tennis players revealed that speed and accuracy differ throughout the day (Atkinson & Spiers, 1998). Six competitive tennis players performed alternate 15 first serves emphasizing speed and 15 second serves emphasizing accuracy. Serve accuracy was more accurate at 0900 when speed was the slowest of the day. Tennis serve speed increased throughout the day as body temperature increased and was fastest in the evening (1800).

This finding of performance was echoed in a 16 kilometer time trial performed in the morning at 0730 or late afternoon around 1730. Atkinson et al (2005) studied eight cyclists, 21 to 28 years of age, who completed four total time trials, two with a warm-up and two without.

In the warm-up test prior to each time trial, the cyclists warmed up for 25 minutes at 60 percent power. Performance at 0730 was 33 to 66 seconds slower than the time trial performed at 1730 with an average of 35 seconds slower after the warm-up. But, the warm-up did have a positive impact on most cyclists with a maximum improvement of 30 seconds.

Memory recall is eight percent better when presented in the afternoon (1500) as compared with the morning (0900) (Manfredini et al. 1998). This suggests that focus, concentration, and short-term memory are better in the afternoon.

As Manfredini and colleagues articulate, an eight percent difference in memory retention is equivalent to sleep deprivation seen with three hours of sleep. Additional studies of specific domains related to sports performance reveal peaks throughout the days with many reaching a height in the afternoon and early evening.

Performance Characteristics	Peak of the Day
Reaction Times	1500 - 1800
Hand/Eye Coordination	1430
Information Processing	1400 - 2100
Strength	1400 - 1845
Emotions/Mood	1400 - 1600

Cappaert (1999) , Winget et al. (1985)

Will training at the same time as a tournament squad help preparation?

Souissi et. al (2001) studied the impact of strength training at a specific time of day and adaptation. Seven participants trained only in the morning (0700 – 0800) with another seven participations training in the afternoon (1700 – 1800).

Participants were tested at the start, after two weeks, and after six weeks of training. At the start of the study, as expected, both groups had higher levels of peak power and peak anaerobic power in the evening than in the morning.

After training, the morning group had no difference in their peak power or anaerobic power between morning and evening while the evening group had peak performance only in the evening. Both groups improved from their initial evening base test.

Another study, Chtourou et al (2012), investigated the impact of lower-extremity resistance training at the same time for 12 weeks and then completion of a two week taper. Thirty-one men were distributed to either a morning (0700 – 0800), evening (1700-1800), or third group that didn't train but did all assessments, the control group.

As expected, the evening group had a higher level of performance than the morning group. But, after the taper, the amount of relative improvement of the morning group was the same as the evening group in regard to short-term performance maximization brought on through the taper. This illustrates that there was a time-of-day adaptation realized through training.

Impact of jet lag

A study of British Olympic athletes found that a five day adjustment was needed during a five time zone transcontinental trip from London to the east coast of the United States (Reilly et al, 2001). The study consisted of nine members of the British men's gymnastics squad, aged 18-30 years.

The athletes experienced individual jet lag symptoms that persisted over these five days as well as reduced performance characteristics such as less leg and back strength and slower reaction times. In order, the sleep-wake cycle was first to establish normality followed by body temperature. In the same study, leg strength was measured throughout the day yielding a significant variation over the four days. The evaluation was done four times each day over the four day period with leg strength varying by as much as sixteen percent at the same time of day.

Recommendations

To maximize your tournament performance, awareness of your circadian rhythms will inform your training schedule. Specifically, I recommend the following:

(1) Schedule squads in the late afternoon and early evening.

As the research indicated, your body temperature will be highest around 1800 hours. It is not surprising that world records in most sports occur in the late afternoon and early evening. With your body temperature at its highest, your physical performance will also be at its highest. Accordingly, scheduling as many squads as possible during this time will aid you in qualifying. In addition, due to the potential to perform your best, it is vital that you take advantage of late afternoon and early evening squads with intense focus.

(2) Train at the time you will compete.

Evidence suggests that training at a set time will improve performance at that time of the day. If you have knowledge of set squad times for important events, it is critical to start training at that time of the day.

(3) Warming up before your squad will benefit performance.

Through a dynamic movement process, your internal temperature will increase leading to higher levels of performance. Warming up is progressively more important in the morning when body temperature and flexibility are at their lowest. For morning squads, complete a 30 minute dynamic warm-up. For afternoon squads, employ a 20 minute warm-up. For late afternoon and early evening, use a 15 minute warm-up. For evening squads, use a 20 minute warm-up.

(4) When bowling morning squads, take notes about decisions and lane play.

With the research base showing an eight percent difference in memory recall between morning and afternoon, it is a realistic fact that you will be less focused and have less concentration in the morning. Accordingly, to help you recall your movements and how you play the lanes, take notes throughout morning blocks. This is particularly important when starting on a morning block and playing a major tournament over many days. Such a tournament places a premium on getting better each day.

(5) For a tournament involving a multiple time zone change, investigate jet lag reduction techniques such as light therapy, diet, exercise, and/or the use of melatonin.

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