Chapter I

INTRODUCTION

The alternation of day and night is an obvious feature of the world in which we live. This is due to the rotation of the earth about its vertical axis once every 24 hours. We organize our work, leisure, other schedules and time for sleep within this solar day. Indeed, humans have ingrained timing mechanisms whereby cycles in physiological functions coincide with the period of light and darkness.

Biological factors, rhythms of man’s nature and environment play a vital role in athletic performance. Major sports contests are not evenly distributed over a sufficiently broad span of the day to yield conclusions about the optimal time for competing. The sports events are scheduled many days, weeks, even months in advance. This may impair performances by forcing the athlete to perform at a time several hours before or after peak circadian performance times. The athlete, in this case, must be prepared to perform at any time on the day of competition.

Performance is directly related to productivity therefore improved physical, psychomotor and mental performance will lead to higher productivity and lower the risks of work related injuries. According to Proverbs et al. (1999b), productivity translates directly
into cost savings and profitability, which is the main goal of every business. This study will prove beneficial for the sport industry since it targets improvement of the physical and mental performance of individuals in relation to the circadian rhythm. Since the whole study is based on the circadian rhythm, it is important to understand the circadian rhythm because temperature is one of the many circadian rhythms that play a vital role in the living organisms’ proper functionality. By gaining a proper understanding of the concepts involved behind these cycles, we can actually take advantage of the body’s natural rhythm to positively impact productivity in a playing environment.

In the 17th century, De Mairan, Jean-Jacques discovered the circadian rhythm. He placed a heliotrope (an herb that turns in the direction of sun) in his closet, away from sunlight, in order to investigate the heliotrope’s inclination to respond to the sun, (Willis, 1990). De Mairan noticed that twenty-four hour patterns (Circadian Rhythms) continued to exist in the movement of the heliotrope’s leaves even when the heliotrope was isolated from external stimulus, which in this case was the sun (Wikipedia Foundation Inc, 2006).

The word Circadian Rhythm comes from the Latin circa, “around”, and dies, “day” which means around a day (Quraishi, 2002). Circadian Rhythm can be defined as the daily biological rhythm. This biological rhythm or the internal clock is sometimes
referred to as the biological clock, which exists in mammals, plants, fungi, insects and so on, and it runs on a 24-hour cycle.

In general, circadian rhythm can be defined by the following criteria (Wikipedia Foundation Inc, 2006):

1. The rhythm persists in constant conditions (For example constant dark) with a period of 24 hours.
2. The rhythm period can be reset by exposure to light or dark pulse.
3. The rhythm proceeds at the same rate within a range of temperatures

The human body has over a hundred circadian rhythms and each unique 24-hour cycle influences an aspect of the bodily function including the sleep-wake cycle, temperature, hormone levels, heart rate, blood pressure, and even the pain threshold (Mayo Foundation for Medical Education and Research, 1995). Figure 1 shows the circadian rhythm of the Pineal and Adrenal glands and the Autonomic nervous system over a 24-hour period. As mentioned earlier, there are over a hundred organs/systems each having their own unique rhythm that they operate on. Figure 2 shows the typical fluctuations of core body temperature over a 24-hour period.
**Figure 1.** Circadian rhythm of the Pineal and Adrenal glands (Hastings, 1998).

**Figure 2.** Typical fluctuations of core body temperature over a 24-hour period (Cass, 2006).
Guinn (1986) reports that we become a different person throughout the day as each cycle goes through its peaks and valleys. Body temperature rises and falls by two degrees every day and Blood Pressure waxes and wanes by as much as twenty per cent. The daily alteration of sleep and wakefulness is accompanied by many changes including activities of nervous system and endocrine systems. There are daily variations also in the rate of hormonal synthesis and in cell divisions. One of the striking manners in which the presence of fundamental 24 hour variations reflected in man and other animals is in changing responsiveness or susceptibility to physical and chemical insults. For example, dose of powerful poisons fully lethal at one time of day, leave animals unharmed at another time.

According to Forrester (1985), the fluctuation of circadian rhythm seems to enable organism to adapt in advance to circumstances that will ensure in a consistently cycling environment. Man’s performance in sport or any other field depends on his movement oriented behaviour which can be noted by others with or without the aid of instruments, and which have their roots in the biological phenomena. This biological phenomena is the foremost which fluctuates...
periodically, and is quite prone to the diurnal which may be interpreted as the circadian rhythms or biological clocks.

According to Walker et al., (1983) variations in the daily rhythm of functional capacity of different systems which are synchronized to a 24 hour day, observe two peculiar aspects. One of them is the time dependent alteration in the levels of physiological process, expressed as circadian range or circadian amplitude. Athletic performances that occur several hours before or after the circadian peak "window" can be potentially subjected to less than optimal performance. The athlete may have no control over athletic events which are scheduled relatively early or late in the day to accommodate scheduling limits or prime time television demands. This type of scheduling may impair performance by forcing the athlete to perform at a time several hours before or after peak circadian performance times.

This problem may particularly be detrimental for athletes with distinct morning and evening chronotypes who may be compelled to compete near the mid-point or tough levels of personal rhythmic performance efficiency.

In sports events the thermoregulatory functions such as playing in the heat, arranging the tournaments in morning, contrast to evening schedules which are recommended for the
majority of sports can limit exercise performance. The clearest demonstration on the importance of circadian rhythms in exercise may not be when they are desynchronized either by jet-lag or nocturnal work schedules. Hence, the findings of this study will definitely help to understand the importance of circadian variations in physiological parameters, physical and playing ability especially in Indian conditions.

Motor and psychomotor performances which exhibit rhythmicity (Reilly, 1987) include simple reaction time, coordination as measured by a pursuit motor task, agility and tapping speed. The close correlation between body temperature and motor performance persists in shift workers during adaptation of both rhythms to a nocturnal regimen. The ties between body temperature and motor performance suggest that exercise is best performed at the crest time of core temperature. The optimal core and muscle temperature for exercise is about 38.3°C and 40°C respectively, the resting temperature is the closest to these values in the evening.

If body temperature is a determining factor, then peak performance should occur in the evening when the temperature of the body at rest is at its highest point. Most athletic world records are set at this time of day: indeed all middle-distance
world records set by British runners (Seb Coe, Steve Cram, Steve Ovett and Dave Moorcroft) were set between 19:00 and 23:00 hours. The only exception in track and field events over the last half century has been the two set pre-noon in men’s shot and women’s javelin.

Skin temperature is a fundamental factor (Mairiaux et al, 1987) in heat exchanges between the body and its environment. The level of skin temperature directly affects the energy transfer by convection and radiation, and also influences heat losses from sweat evaporation by determining the saturated vapour pressure at the skin surface. The assessment of skin temperature is thus of great importance for thermal balance evolution in working man.

An internal pacemaker within our brain signals hormones to maintain the circadian rhythm. In order to coincide with our 24 hour clock, the pacemaker requires environmental cues, with light being the most effective. Where people have been deprived of light, their internal circadian rhythm adjusts to a 24.5-hour cycle. While this could suggest that the earth was once much larger, or that our species migrated from another planet, it is more believable to be a minor deficiency in our complex human physiology. Regardless of what we believe, the implications of
this biological phenomenon can be quite significant in sports performance.

**Need of the study**

The available literature survey indicates that not much has been done when it comes to the evaluation of the effect of circadian rhythm on the psychomotor performance and mood states in humans and no research were found on the effect of the circadian rhythm on the psychomotor performance on trained and untrained men. Various studies have looked at the circadian rhythm of hormones such as melatonin and plasma cortisol, core body temperature, skin temperature, and the circadian sleep-wake rhythms and their effect on the human body; however, no research has been conducted on the effect of circadian rhythm on the psychomotor performance and mood states of individuals. In addition, the literature lacks research on the effects of circadian rhythm on the comparative performance of trained and untrained men. Hence the researcher made an attempt to find out the variations in selected psychomotor variables and profile of mood states resulting from circadian rhythm between trained and untrained men.
**Statement of the Problem**

The purpose of the study was to determine the variations in selected psychomotor variables and profile of mood states resulting from circadian rhythm between trained and untrained men.

**Objectives of the study**

This study aimed at investigating the influence of circadian rhythm by achieving the following five objectives which are as follows:

1. Determine the effect of circadian rhythm on the psychomotor performance of trained and untrained men.

2. Determine the effect of circadian rhythm on the mood states of trained and untrained men.

3. Determine whether a common circadian rhythm pattern exists for all the participants or each group has a unique rhythm.

4. Determine the times of the day when the participants perform their best.

5. Determine whether the effect of the circadian rhythm on the psychomotor performance and mood states are different in trained and untrained men or the same.

**Delimitations**

The study was delimited in the following factors.
1. To achieve the purpose of the study, 15 trained and 15 untrained male were selected from the affiliated colleges of Manonmaniam Sundaranar University, Tirunelveli.

2. The age of the subjects ranged from 17 to 25 years.

3. The selected subjects were tested at six different times of the day such as 02:00, 06:00, 10:00, 14:00, 18:00 and 22:00 hours.

4. Reaction time, flexibility, agility, balance and profile of mood states were selected as criterion variables.

5. The selected variables were tested with standardized test items.

**Limitations**

The following limitations were considered while interpreting the results of the study.

1. Non-availability of highly sophisticated instruments was considered a limitation for the purpose of this study.

2. No effort was made either to control or assess the quantum of the food ingested, life style, psychological stresses and other factors that affect metabolic function.
3. No attempt was made to determine whether the subjects have the same degree of motivation during the various times of the day of testing.

4. Changes in atmospheric pressure, temperature, relative humidity and such other meteorological factors during the period of administering the test could not be controlled or assessed.

**Hypotheses**

1. There may be significant difference between trained and untrained men irrespective of the different times of the day on the selected psychomotor variables and profile of mood states.

2. There may be significant difference among the different times of the day irrespective of games such as trained and untrained men on the selected psychomotor variables and profile of mood states.

3. There may be significant difference among the different times of the day between trained and untrained men on psychomotor variables and profile of mood states.

**Significance of the Study**

The comparative nature of human being is as old as his origin. Every individual or nation wants to establish his or her supremacy over other individuals or nations. This fact
stimulates, inspires and motivates everyone to sweat and strive to run faster, jump higher, throw farther and exhibit greater speed, power, strength, endurance and skills in the present international sports arena.

In a new training schedule one must also consider the qualifying rounds which often seal a player's fate because they are fixed at a time of the day to which the athlete is not accustomed.

Generally, circadian rhythms do affect performance and the coach must take this into account when measuring physical performance and coordination skills as well as in daily training and competition. Therefore, the findings of this study will be of significance in the following way:

1. The findings of the study may add to the existing knowledge with regard to the circadian variation on the selected physical and physiological variables of athletes.

2. The results of the study may provide guidelines which will help the physical educators and coaches in preparing the training schedules and travel plans for their players in their respective games.
3. The findings of this study will add to the quantum of knowledge in the area of Sports Physiology and Training Methods.

4. The study may help to assess the status of psychomotor and mood states among athletes.

**Definitions of the Operational Terms**

**Circadian Rhythm**

Circadian Rhythm is pertaining to any biological cycle (e.g. of varying intensity of metabolic or physiological process, or some feature of behaviour) which is repeated usually approximately every 24 hours.

Definitions of terms commonly used when discussing circadian rhythms are cycle, the shortest part of a rhythm which repeats itself indefinitely; period, the time occupied by a cycle which, if it is circadian, is about 24 hours; amplitude, the distance from the peak to the trough; phase, the phase of a periodically refers to any particular in the cycle, maximum or minimum, or the point where the value rises past the mean; phase-shift, an advancement or retardation of the period with no alteration of its form; Acrophase, time of the peak when a best-fitting sine curve has been calculated. If no such curve has been
fitted then the term peak is used; Nychthermal, implies that a rhythm has been measured in the presence of at least some of the normal periodicities of the solar day.

**Reaction time**

The length of the time elapsed between the presentation of the stimuli and actual beginning of the movement of response (*Jensen, 2006*).

**Flexibility**

Flexibility is the ability of an individual to move the body and its parts through a wide range of motion as possible without strain to the articulations and muscle attachments (*Johnson and Nelson, 1984*).

**Agility**

Agility is the ability to change body position rapidly and accurately without losing balance. It is important in sports and activities in which opponents or obstacles have to be avoided. It is a basic component of physical fitness. Although its exact nature has not been determined, it depends on muscular power, reaction time, coordination, and dynamic flexibility (*“Agility is”, 2009*).

**Balance**

The ability to maintain a stable position while either stationary (static balance) or moving (dynamic balance). Balance is achieved by the action of reflexes involving the eyes, the balance organs in the
semi-circular canals of the ears, pressure receptors in the skin (particularly on the soles of the feet), and stretch receptors in muscles and joints. Good balance is needed for many sports, especially those requiring sudden changes in movement, such as gymnastics and tennis (“The ability”, 2003).

**Mood States**

An emotional condition that persists for some time, such as irritable, cheerful, or aggressive mood (“An emotional’, 2007).

**Profile of Mood States (POMS)**

A psychological test designed to measure a person's affective states. These include tension, depression, anger, vigour, fatigue, and confusion. Unlike personality traits, mood states are thought to be transitory and specific to a given situation, although moods can also be measured for recent prolonged periods such as the past several months. POMS is a popular research tool among sport psychologists ("A psychological", 2008).