Chapter II

REVIEW OF RELATED LITERATURE

Circadian rhythms are of primary interest when it comes to the functionality of living organisms. It is extremely important to understand the factors that have an impact on the 24 hour cycle, circadian rhythm, in human beings either positively or negatively for healthy and productive functionality of human beings. Most researchers tried to find the impact of various circadian rhythms on the overall functionality of human beings in order to elevate the level of performance in human beings directly or indirectly. The following section is a review of literature related to various studies performed on different circadian rhythms to determine the impact on the performance.

The reviews of the literature have been classified under the following headings.

1. Studies related to Circadian Rhythm on Psychomotor Variables

2. Studies related to Circadian Rhythm on Mood State

1. Circadian Rhythm on Psychomotor Variables

Ilmarinen, Ilmarinen, Korhonen & Nurminen (1980) described, in parametric terms, the variation of these functions and estimate the times and values of their maximum and minimum responses.
Statistically significant periodic regression effects were found for the following functions: oral temperature; systolic blood pressure; heart rate at rest, during work (245 and 270 W) and after a 5-min recovery; ratings of perceived exertion; strength of hand grip; and neuromuscular coordination measured with a seesaw board balance test. The results suggest that the measured capacities of muscle strength and neuromuscular coordination are the lowest, that physical work is perceived as the heaviest, and recovery after work is the slowest at night.

Baxter and Reilly (1983) examined the effect of time of day on all-out swim performances. Fourteen subjects performed maximal front crawl swim tests on separate days over 100 m. and 400 m. at 5 different times of day between 06.30 h. and 22.00 h. Performance showed a significant linear trend with time of day in close though not exact association with the circadian rhythm in oral temperature: a goodness of fit test confirmed that the values predicted from linear trend analysis coincided with the measured values. No significant rhythm was observed in ankle and shoulder flexibility, grip strength or peak expiratory flow rate. It was concluded that maximal swimming trials are best scheduled for the evening and worst in the early morning. Specific fitness factors cannot clearly account for the higher exercise capability in the evening which is strongly related to the circadian curve in body temperature.
Reilly and Baxter (1983) explored the hypothesis that a fixed relative loading of high intensity aerobic effort could be sustained for longer in the evening compared with the morning. Eight females cycled to exhaustion at 95% VO2 max at 06.30 h. and at 22.00 h. after a 5 min, moderate load of 40% VO2 max. Oral temperature was 0.4 degrees C higher at 22.00 h. It was concluded that superior exercise performance in the evening may be attributed to a greater tolerance for high intensity exercise which is closely associated with the acrophase in body temperature.

Folkard, Wever & Wildgruber (1983) determined circadian rhythms are known to exist in many measures of human performance efficiency as well as in physiological processes. Normally, the pronounced 24-h time cues, or ‘zeitgebers’, in our environment result in both oscillators, and hence all circadian rhythms, running with a period of 24 h. However, under altered sleep/wake schedules, and in conditions of temporal isolation, the temperature rhythm and sleep/wake cycle may separate from one another and run with distinctly different periods. When such ‘internal desynchronization’ occurs, other physiological rhythms have been found to run in synchrony with one or other of these two functions. This finding forms the basis of current multi-oscillatory models. The results indicate control of working memory performance rhythms by a previously unidentified oscillator with an autonomous period of about 21 hour.
Wright et al (1983) determined the effects of travel across time zones (jet-lag) on exercise capacity and performance. Eighty-one healthy male soldiers, aged 18-34, were studied for 5 d before and 5 d after an eastward deployment across six time zones. Fatigue, weakness, headache, sleepiness, irritability, and other commonly reported symptoms occurred in the majority of subjects. Isometric strength of the upper torso, legs, and trunk extensor muscles also was not changed. Dynamic strength and endurance of elbow flexors declined significantly. Dynamic knee extensor strength and endurance scores exhibited a progressive decrement prior to translocation and were inconsistent suggesting that the stress of repetitive testing outweighed any jet-lag effects on performance capacity. These findings indicate that certain symptoms and physiological capacities are affected as a result of multiple time zone translocation.

Reinberg, Proux, Bartal, Lévi & Bicakova-Rocher (1985) investigated circadian rhythms of sleep-wake, self-rated fatigue and mood, oral temperature, eye-hand skill and right and left hand grip strength were investigated in eight subjects: five males (21-28 years of age), members of the French sabre fencing team selected for the 1984 Olympic Games in Los Angeles, and three females (19-26 years of age) practicing fleuret (foil) fencing as a sports activity. On the average six measurements/day/variable/subject were performed. It was concluded that, physiologic synchronization of circadian rhythms may be a predictor of good performance however, internal
desynchronization as shown previously may be a trivial phenomenon and thus does not imply in itself alterations of either health or performance.

Deitrick, Holmes & Murphy (1985) evaluated physiological characteristics of elite sport parachutists. The physiological characteristics of 10 male elite sport parachutists were determined and compared to 10 male non-sport parachutist controls and other selected elite athletes. Mean total free fall time was 22 h and 40 min. Compared to the non-sport parachutist control group, the elite sport parachutists were significantly higher in aerobic power, vital capacity, maximum heart rate, and back hyperextension flexibility. It was concluded that, the two groups were not significantly different with respect to resting heart rate, absolute body weight, dominant hand-grip strength, or lower back/hamstring flexibility as measured by the sit-and-reach test. The elite sport parachutists were approximately mid-range in absolute body weight and lower back/hamstring flexibility when compared to other selected elite athletes.

Reilly and Down (1992) investigated the influence of time of day on measures of anaerobic power and anaerobic capacity. Twelve male subjects, aged 18-22 years, performed a stair run test, a standing broad jump and the Wingate Anaerobic Test on twelve separate occasions. These were at 02:00, 06:00, 10:00, 14:00, 18:00 and 22:00 hours, duplicate measurements being obtained at each time point. Subjects’ diet and activity prior to exercise and the laboratory
temperature were controlled. It was concluded that, there was a rhythm in performance on the stair run and the broad jump tests, in phase with the curve in rectal temperature. Results for peak power and mean power production on the Wingate test did not display a significant circadian rhythm. The stair run and broad jump tests seem to be more sensitive to circadian rhythmicity than does the Wingate Anaerobic Test.

Atkinson, Coldwells, Reilly & Waterhouse (1993) compared circadian rhythms in physiological, subjective, and performance measures between groups exhibiting different levels of habitual physical activity. Fourteen male subjects, aged 19-29 years, were assigned to a physically active (group I, n = 7) or a physically inactive (group II, n = 7) group on the basis of leisure-time physical activity. Rectal temperature, oral temperature, resting pulse rate, subjective arousal and sleepiness were measured at 02:00, 06:00, 10:00, 14:00, 18:00 and 22:00 in a counter-balanced sequence for each subject. Whole-body flexibility, back and leg strength, grip strength (right and left), flight time in a vertical jump, PWC150, and self-chosen work-rate were also recorded at each time point. At least 8h separated each test session. These results confirm with physical performance measures that rhythm amplitudes are higher for physically fit subjects. This could be attributed to greater early-morning troughs in the measures for active individuals.
Gupta and Pati (1994) determined characteristics of circadian rhythm in six variables of morning active and evening active healthy human subjects. Ten apparently healthy human subjects, inhabitants of dry and hot tropical climate, volunteered for the study. They were instructed to self-measure, several variables, such as oral temperature, heart rate, subjective fatigue, subjective drowsiness, finger counting speed and random number adding speed, daily, preferably at an interval of 4h, for 10-15 days. The results clearly show a higher order of internal synchronization among all the variables. Comparison of acrophase locations between morning active and evening active individuals reveals that the peaks in oral temperature, heart rate and random number adding speed occurs earlier in morning active individuals.

Reinberg, Bicakov Rocher, Gorceix, Ashkenazi & Smolensky (1994) determined the placebo effect on the circadian rhythm period tau of temperature and hand-grip strength rhythms. Two different medications, one assumed to be a tranquilizer and the other an antifatigue agent, were tested. Both were found to be ineffective and thus were viewed as placebos and named P1 and P2. The effect of P1 and P2 on the circadian rhythms of a set of variables (e.g., sleep/wake, oral temperature and grip strength of both hands) were monitored by five to 10 measurements per day over three consecutive 8- to 10-day spans. It was concluded that, the gender-related difference was obliterated by placebos. Similarly desynchronized
circadian rhythms of left and right hand-grip strength were observed in both men and women during the control span, which were all obliterated by placebo but only in men.

Koutedakis (1995) determined seasonal variation in fitness parameters in competitive athletes. In elite competitors, anaerobic parameters, heart frequencies, subcutaneous fat, flexibility and haemoglobin levels remain relatively unchanged throughout the year. Aerobic metabolism and muscular strength may demonstrate noticeable (mostly unfavourable) changes, and plasma hormonal levels normally follow changes in training intensities. Aspects related to long term fatigue and genetics, and to appropriate training are just a few explanations for these observations. It was concluded that, seasons of training and competition result in no significant changes in flexibility measurements. Similar changes to those found in novices and in athletes at low competitive levels may also be seen in children and adolescents engaged in sport, although their fitness improvements are consistent with normal patterns of growth and development. No differences have been identified between male and female athletes participating at different competition levels.

Reilly and Garrett (1995) compared responses to sustained exercise in the morning and in evening. Rectal temperature was measured pre-exercise and throughout a 60 min test on a cycle ergometer against a fixed frictional resistance in seven males (aged 19-24 years). The subjects were instructed to work as hard as possible
over the entire exercise period but could vary the pedal frequency at any time. Power output was calculated by computer, utilising an optical detection device to monitor flywheel revolutions. Tests were performed at 08:30 and 17:30 h, balanced for order with at least 72 hours between tests. It seems that the pacing of endurance performance is affected in the morning, but without any overall effect at least for the duration examined and at the ambient environmental temperature of 17-19 degrees C.

Wilson and Murphy (1995) examined the efficacy of several tests of muscular strength and power in their capacity to be related to performance, their ability to effectively discriminate between individuals of different performance levels and their sensitivity in detecting training induced changes to performance. Thirty healthy active subjects performed the following maximal tests of muscular function: (1) Vertical jump; (2) Isokinetic knee extension at 1.05, 3.14 and 5.24 rads s⁻¹; and (3) Isometric rate of force development. Performance was assessed by the peak power output achieved on a cycle test. In addition, subjects participated in a 10 week resistance training program. It was concluded that, alterations to training programs for athletes should be based on changes in actual performance, as opposed to muscular function tests.

Atkinson and Reilly (1996) discussed circadian variation in sports performance. The majority of components of sports performance, e.g. flexibility, muscle strength, short term high power
output, vary with time of day in a sinusoidal manner and peak in the early evening close to the daily maximum in body temperature. The normal circadian rhythms can be desynchronised following a flight across several time zones or a transfer to nocturnal work shifts. Circadian rhythms are larger in amplitude in physically fit individuals than sedentary individuals. It was concluded that, athletes over 50 years of age tend to be higher in 'morningness', habitually scheduling relatively more training in the morning and selecting relatively higher work-rates during exercise compared with young athletes. These differences should be recognised by practitioners concerned with organising the habitual regimens of athletes.

Reinberg et al (1996) discussed oral contraceptives alter circadian rhythm parameters. Sixteen healthy women users and nonusers of oral contraceptives (OC) volunteered to document a set of circadian rhythms. Nine were taking OC providing ethynyl estradiol combined with DL- or L-norgestrel or norethisterone. It was concluded that, no group difference was detected in any other documented rhythms: diastolic blood pressure, grip strength of both hands, oral temperature, self-rated fatigue, and the skin variables of urea, lactate, triglycerides, and acid phosphatase activity.

Meyer and Sterling (2000) quantified the physical, hematological, and exercise response of female equestrian athletes in order to provided greater insight into the health fitness of this unique competitor, and to compare results to other better studied sport
athletes. Following written informed consent, physiological assessments were performed on 24 collegiate female equestrian athletes to quantify aerobic power, anaerobic power, body composition, muscular strength, blood chemistries, and coronary risk profile. It was concluded that, although working with equine poses a constant danger, the lack of adequate physical conditioning of the equestrian may be a contributing factor in the growing number of injuries. When compared to female athletes in other sports, exercise performance was found to be lower.

Reilly, Atkinson & Budgett (2001) monitored a selection of subjective, physiological and performance variables in elite athletes and sedentary subjects following a westerly flight across five time zones, and to examined whether the promotion of sleep by means of a low-dose benzodiazepine drug influences these responses to transmeridian travel. Subjects comprised eight members of the British men's gymnastics squad, aged 18-30 years, and nine members of the British Olympic Association's support staff, aged 24-55 years (4 females, 5 males). A test battery was administered to the subjects at 07:00, 12:00, 17:00 and 21:00 hours on the first full day of arrival and then on alternate days. Immediately before retiring to bed on days 1, 2 and 3, subjects were administered, in a double-blind fashion, either 10mg of temazepam or a placebo. Measures in the test battery included sleep quality, sleep length, subjective jet lag, tympanic temperature, one-, two-, four- and eight-choice reaction time, grip
strength, leg strength and back strength. It was concluded that, both
the treatment and control groups, subjective jet lag and performance
were worst in the evening of the first full day after arrival, and the
young athletes slept better than the older support staff that same
night.

Paul et al (2001) determined whether either melatonin or
zopiclone could facilitate early circadian sleep, and to assess whether
either of these medications would result in a psychomotor
performance decrement which would preclude their use in aircrew.
Thirteen subjects from DCIEM completed a double-blind cross-over
protocol. All subjects were assessed for psychomotor performance
during 3 drug conditions, which were separated by one week. All
subjects were tested for psychomotor performance, on both nights of
each of the 3 drug conditions, pre- and post-sleep. Further, during the
early circadian drug night, all subjects were tested every hour after
arising at 23:45 h (24:00 h until 07:00 h. At the beginning of each
psychomotor test session, subjects were asked for their subjective
levels of sleepiness and fatigue. It was concluded that, both zopiclone
and melatonin improved sleep relative to placebo. After sleep inertia,
performance recovered to pre-sleep levels for all tasks and was
sustained at that level throughout the balance of the testing period.

Lafrance, Paquet & Dumont (2002) examined the similarities
between the diurnal time courses in the waking EEG activity and the
psychomotor performance. EEG recordings and performance results
for the Four Choice Reaction Time Test (FCRTT) were obtained every two hours, from morning to late evening period, in 8 young normal subjects. ANOVAs were used to verify the presence of diurnal variations in the two measures. Three EEG frequency bands (delta, sigma, and beta1) and the reaction time measures varied across the daytime. It was concluded that, the changes in the sigma and the beta1 bands were similar to the diurnal variations in the reaction time measures. It is suggested that the changes in the sigma and the beta1 bands may facilitate the processing of the sensorimotor treatment.

Reinberg, Bicakova-Rocher, Mechkouri & Ashkenazi (2002) assessed the influence of age and gender on the difference in tau of the NDH and DH, as it relates to the corresponding cortical hemisphere of the brain, in comparison to the rhythm in handgrip strength. Healthy subjects, 9 adolescents 10-16 yr of age and 15 adults 18-67 yr of age, active between 08:00 +/- 1 h and 23:00 +/- 1:30 h and free of alcohol, tobacco, and drug consumption volunteered. Data were gathered longitudinally at home and work 4-7 times daily for 11-20 d. At each test time the following variables were assessed: grip strength of both hands single reaction time to a yellow signal (SRT); and CRT to randomized yellow, red, or green signal series with varying instruction from test to test. Rhythms in the performance in SRT, CRT, and handgrip strength of both DH and NDH were explored. The sleep-wake rhythm was assessed by sleep-logs, and in a subset of 14 subjects it was also assessed by wrist actigraphy (Mini-
Motionlogger: AMI, Ardsley NY). Exploration of the prominent period tau of time series was achieved by a special power spectra analysis for unequally spaced data. Cosinor analysis was used to quantify the rhythm amplitude A and rhythm-adjusted mean M of the power spectral analysis determined trial tau. A 24h sleep-wake rhythm was detected in almost all cases. In adults, a prominent tau of 24 h characterized the performance of the easy task by both the DH and NDH. In adults a prominent tau of 24 h was also detected in the complex CRT task performed by the DH, but for the NDH the tau was < 24 h. This phenomenon was not gender-related but was age-related since it was seldom observed in adolescent subjects. Hand-side differences in the grip strength rhythms in the same individuals were detected, the tau being ultradian rather than circadian in adolescent subjects while in mature subjects the tau frequently differed from that of the rhythm in CRT. These findings further support the hypothesis that functional biological clocks exist in both the left and right hemispheres of the human cortex.

Smith (2003) discussed a framework for understanding the training process leading to elite performance. The dynamics of training involve the manipulation of the training load through the variables: intensity, duration and frequency. In addition, sport activities are a combination of strength, speed and endurance executed in a coordinated and efficient manner with the development of sport-specific characteristics. Short- and long-term planning (periodisation)
requires alternating periods of training load with recovery for avoiding excessive fatigue that may lead to overtraining. Overtraining is long-lasting performance incompetence due to an imbalance of training load, competition, non-training stressors and recovery. Finally, at competition time, optimal performance requires a healthy body, and integration of not only the physiological elements but also the psychological, technical and tactical components.

Varkevisser and Kerkhof (2003) explored whether the test battery could assess circadian rhythmicity under constant routine conditions. Performance, body temperature, and subjective sleepiness of 12 healthy subjects were measured. The test battery consisted of a sleepiness questionnaire and three performance tests: a vigilance detection test, a working memory test, and a choice-reaction time test. The subjects were divided into early-start and late-start groups and were subjected to the constant-routine protocol. In conclusion, the present test battery appeared to be a good tool for future assessment of performance under natural conditions.

Bambaeichi, Reilly, Cable, & Giacomoni (2005) determined the interaction between the effects of partial sleep loss and time of day on muscle strength in females. Eight sedentary eumenorrheic females took part in the study, in a counterbalanced design. Measurements of muscle strength were carried out at 06:00 and 18:00 hours after the one control night and the one night of partial sleep loss, during menses. Muscle strength and isometric peak torque of knee extensors
and flexors. It was concluded that, no significant diurnal variation was observed for the other muscle strength measures. No significant effect of partial sleep loss or interaction effect (sleep x time of day) was observed for muscle strength measures. As the effect of time of day was observed with some of the muscle strength measures, it is suggested that, in designing future studies using females, the control of time of day is essential.

Cronin and Sleivert (2005) investigated methods to improve power output and its transference to athletic performance. One issue that makes comparisons between studies difficult is the different modes of dynamometry (isometric, isokinetic and isoinertial) used to measure strength and power. However, it is recognised that isokinetic and isometric assessment bear little resemblance to the accelerative/decelerative motion implicit in limb movement during resistance training and sporting performance. It was concluded that, Pmax is affected by the training status of the individuals; however, other strength variables could quite possibly be of greater importance for improving functional performance. If Pmax is found to be important in improving athletic performance, then each individual’s Pmax needs to be determined and they then train at this load.

Blatter et al (2006) compared PVT performance in 16 young and 16 elderly healthy subjects during a 40-h sleep deprivation and a 40-h multiple nap protocol under dim light and constant posture conditions in a balanced crossover design. Independent of age and sleep pressure
conditions, women exhibited significantly slower reaction times (RTs) than men. This effect became more apparent with increasing time elapsed into both the 40-h NAP and SD protocol. It was concluded that, the gender effect as a different strategy in women when performing the PVT, although the instructions to be 'as fast as possible' were identical. Not only sleepiness and circadian phase, but also age and gender are major factors that may contribute to attentional failures in extended work shifts and during nighttime work shifts.

Bullock, Martin, Ross, Rosemond & Marino (2007) quantified the impact of eastward long haul travel on diurnal variations in cortisol, psychological sensations and daily measurements of physical performance. Five elite Australian skeleton athletes undertook a long haul eastward flight from Australia to Canada (LH(travel)), while seven elite Canadian skeleton athletes did not travel (NO(travel)). Salivary cortisol was measured on awakening, 60 min and 120 min after awakening. Psychological sensations were measured with a questionnaire, and maximal 30 m sprints were performed once a day between 09:30 and 11:00 h local time. It was concluded that, despite a distinct phase change in salivary cortisol rhythmicity and the athletes perceiving themselves as "jet lagged", minimal disturbances in "one-off" maximal sprinting ability between 09:30 and 11:00 h local time were seen in a group of elite skeleton athletes after long haul eastward travel from Australia to Canada.
Reilly et al (2007) determined whether game-related skills varied with time of day in phase with global markers of both performance and the body clock. Eight diurnally active male association football players participated. Measurements were made on different days at 08:00, 12:00, 16:00, and 20:00 h in a counterbalanced manner. Time-of-day changes in intra-aural temperature, grip strength, reaction times, flexibility, juggling and dribbling tasks, and wall-volley test were compared. Results indicate football players perform at an optimum between 16:00 and 20:00 h when not only football-specific skills but also measures of physical performance are at their peak. Body temperature peaked at a similar time, but positive mood states seemed to peak slightly earlier. While causal links cannot be established in these experiments, the results indicate that the diurnal variation of some aspects of football performance is affected by factor(s) other than body temperature alone.

Edwards, Waterhouse & Reilly (2008) compared the dominant and non-dominant hand with regard to circadian rhythms of accuracy of performance at a task that required eye-hand coordination and sub-maximum muscle contraction, as well as to investigate if there were differences between the dominant and non-dominant hands in the associations between circadian rhythms of performance and core temperature and time awake. The task consisted of using a larger counter to flick a set of 20 smaller counters to land as near as possible to the center of a target. The nearer to the center of the target
a counter landed, the higher the score awarded. Three measures of accuracy were calculated: the total score, the number of times the counter missed the target altogether, and the mean score for those counters that hit the target. Seventy-eight healthy participants performed the task at each of six test sessions distributed every 4 h throughout the day (at 08:00, 12:00... 04:00 h), the participants then having been awake for about 1, 4... 20 h, respectively. Before each test session, sub-lingual temperature was measured, and estimates of the individual's alertness and fatigue were obtained. Temperature, alertness, and fatigue all showed circadian rhythms that were phased conventionally. It was concluded that, accuracy of performance showed significant circadian rhythms that were phased closer to the rhythms of alertness and fatigue than to that of oral temperature.

Bougard, Moussay & Davenne (2008) assessed time of day and sleep deprivation impacts on motorcycling performance taking into consideration key variables, such as reaction time, motor coordination and vigilance that are principally involved in a riding task. Eight subjects participated in different tests sessions planned at 06:00 and 18:00h after a normal night’s sleep and after a night of total sleep deprivation. During each session all subjects completed "laboratory" and "motorcycling" tests that were designed to assess each of the variables tested. As classically observed in sport performance, motorcycling performance demonstrates a time of day fluctuation by increasing from 06:00 to 18:00h during the day after a normal night’s
sleep. It was concluded that, during complex tasks, compensation mechanisms may be set up between different resources so as to maintain a good level of performance.

Gander, Millar, Webster & Merry (2008) examined work patterns, sleep and performance of 28 anaesthesia trainees and 20 specialists across a two-week work cycle in two urban public hospitals. Trainees at one hospital worked back-to-back 12 h shifts, while the others usually worked 9 h day shifts but periodically worked a 14 h day (08:00-22:00 h) to maintain cover until arrival of the night shift (10 h). On 11% of day shifts and 23% of night shifts, trainees were working with > or =2 h of acute sleep loss. However, average sleep loss was not greater on night shifts, possibly because workload at night in one hospital often permitted some sleep. It was concluded that, for both trainees and specialists, robust circadian variation in PVT performance was evident in this complex work setting, despite the potential confounds of variable shift durations and workloads. The relationship between PVT performance of an individual and the safe administration of anaesthesia in the operating theater is unknown.

Edinger, Means, Carney & Krystal AD. (2008) examined psychomotor (reaction time) performance deficits and their relation to subjective and objective sleep measures among individuals with primary insomnia (PI). This study was conducted at affiliated VA and academic medical centers using a matched-groups, cross-sectional research design. Seventy-nine (43 women) individuals with PI and 84
well-screened normal sleepers. Participants underwent 3 nights of polysomnography (PSG) followed by daytime testing with a 4-trial multiple sleep latency test (MSLT). Before each MSLT nap, they rated their sleepiness and completed a performance battery that included simple reaction time (SRT), continuous performance (CPT), and 4 switching attention (SAT) tests. Results confirm that PI sufferers do show relative psychomotor performance deficits when responding to challenging reaction time tasks, and these deficits appear related to both objective and subjective sleep deficits.

Rueckriegel et al (2008) determined the influence of age and movement complexity on kinematic hand movement parameters. One hundred and eighty-seven children and adolescents, range were included in the study. Participants performed drawing and handwriting tasks on a digitizing graphic tablet. Movements were segmented into strokes and several kinematic parameters were calculated. The kinematic parameters that were analyzed represented speed, automation, variability and pressure. It was concluded that, future analyses of impaired movement in children and adolescents need to take age and gender into consideration.

Bougard, Moussay, Gauthier, Espié & Davenne (2009) determined waking time and whether or not breakfast is consumed are currently considered to influence the diurnal fluctuation in data collected in the morning at 06:00 h and evening at 18:00 h. Nineteen male subjects participated in four test sessions to examine if wake-up
time (04:00 h or 05:00 h) and eating or not eating breakfast influence psychomotor performance capacity at 06:00 h. All four sessions were separated by >/=36 h and were completed in a counterbalanced order. Each test session comprised sign cancellation, Epworth Sleepiness Scale, simple reaction time, and manual dexterity tests. The results indicate that psychomotor performance when evaluated at 06:00 h under each of the four different study situations is not statistically significantly different.

Edwards & Waterhouse (2009) investigated the effects of one night of partial sleep deprivation upon diurnal rhythms of accuracy and consistency in throwing darts. Sixty subjects were tested five times per waking day on two occasions for accuracy and reliability in throwing 20 darts at a target. Two experimental conditions were investigated: following a normal nocturnal sleep (7-8 h sleep, normal) and after having retired to bed 4 h later than normal the previous night but rising at the normal time (3-4 h sleep, sleep deprivation). Sublingual (core) temperature and subjective estimates of alertness and fatigue were measured in all sessions. Performance at throwing darts was assessed by three methods: mean distance of the dart from the bulls-eye; number of times the target was missed; and variability of the scores from the darts thrown. We conclude that the simple task of throwing darts at a target provides information about chronobiological changes in circumstances where time awake and sleep loss might affect psychomotor performance.
Jasper, Häussler, Marquardt & Hermsdörfer (2009) determined whether the motor process of handwriting is influenced by a circadian rhythm. Nine healthy young male subjects underwent a 40-h sleep deprivation protocol under constant routine conditions. Starting at 09:00 hours, subjects performed every 3 h two handwriting tasks of different complexity. Handwriting performance was evaluated by writing speed, writing fluency and script size. The frequency of handwriting, as a measure of movement speed, revealed a circadian rhythm, validated by harmonic regression, with a slowing at the time of the onset of melatonin secretion (22:17 hours) and a trough in the very early morning at around 03:30 hours. Our results show for the first time a clear circadian rhythm for the production of handwriting.

Jasper, Haussler, Baur, Marquardt & Hermsdorfer (2009) determined whether the motor process of handwriting is influenced by a circadian rhythm during writing tasks of high everyday relevance and analyzed the relationship to the circadian rhythm of grip strength. Ten healthy young male subjects underwent a 40 h sleep-deprivation protocol under constant routine conditions. Starting at 09:00 h, subjects performed three handwriting tasks of increasing perceptual-motor complexity and assessed grip strength of both hands every 3 h. The handwriting tasks revealed a coincident circadian rhythm for the frequency of handwriting as a measure of movement speed, with slowest writing speed at 03:16 h. The results show a clear circadian rhythm in the speed of handwriting and grip strength.
**Circadian Rhythm on Mood State**

Naitoh, Beare, Biersner & Englund (1983) examined whether an 18-h routine (6-h on, 12-h off watch) during a 10-week submerged patrol affected the 24-h circadian rhythm in oral temperature, Thayer's activation, Mood 'Activity' (MA) and Mood 'Happiness' (MH). They were observed during three phases of the patrol. Loss of 24-h rhythm in 'Activation', 'Happiness', and 'Activity' was predominantly due to a wider dispersion of TOPs. The 18-h routine did appear to exert a small modulating effect on rhythmic activity in the variables examined in this study. Since the sleep/wakefulness cycle was well entrained by the 18-h routine, the submariners experienced a spontaneous internal desynchronization between the activity cycle and the cycles or oral temperature and psychological states.

Monk, Fookson, Moline & Pollak (1985) determined circadian rhythmicity in various psychological functions under the chronobiologically 'pure' condition of temporal isolation, a battery of mood and performance tests were administered about 6 times per day to a heterogeneous group of 18 subjects (ages 19-81, 5 female). Each subject spent about 5 days in temporal isolation, entrained to a routine equivalent to his/her own habitual sleep/wake cycle. Average time of day functions were obtained for the mood and performance variables, and compared to rectal temperature data subjected to exactly the same statistical analysis. It was concluded that, significant time of day effects were found in the mood variables of alertness,
sleepiness, weariness, effort required, happiness and well-being. Times of 'best' mood were different from the time of peak temperature. Moreover, the minima of sleepiness, weariness and effort occurred earlier in the day than the maximum of alertness. Significant time of day effects were also found in the speed with which search and dexterity tasks were completed.

Winget Charles, Deroshia Charles & Holley Daniel (1985) discussed circadian rhythm and athletic performance. Circadian rhythmicity in components of athletic performance can be modulated by workload, psychological stressors, motivation, "morningness/eveningness" differences, social interaction, lighting, sleep disturbances, the "postlunch dip" phenomenon, altitude, dietary constituents, gender, and age. These rhythms can significantly influence performance depending upon the time of day at which the athletic endeavor takes place. Disturbance of circadian rhythmicity resulting from transmeridian flight across several time zones can result in fatigue, malaise, sleep disturbance, gastrointestinal problems, and performance deterioration in susceptible individuals (circadian dysrhythmia or "jet-lag"). Factors influencing the degree of impairment and duration of readaptation include direction of (light, rhythm synchronizer intensity, dietary constituents and timing of meals, and individual factors such as morningness/eveningness, personality traits, and motivation. It is the intent of the authors to increase awareness of circadian rhythmic influences upon physiology
and performance and to provide a scientific data base for the human circadian system so that coaches and athletes can make reasonable decisions to reduce the negative impact of jet-lag and facilitate readaptation following transmeridian travel.

John De Castro (1987) investigated using diary self-reports of spontaneous food intake. Eight male and 30 female undergraduate students recorded what they ate, when they ate it, and their mood at the time of ingestion in a diary over a consecutive nine day period. Self-ratings of depression, energy, and anxiety were made at the beginning of each meal on three seven-point scales. This suggests that humans obtain less satiety from a given amount of food later in the day than earlier. It is postulated that this represents eating which anticipates the overnight fast. These data clearly demonstrate the efficacy of the approach and the orderly, analyzable nature of the spontaneous eating behavior of humans.

Reilly (1990) examined performance are those of body temperature and the sleep-wake cycle. Many components of exercise performance are closely related to the body temperature curve which peaks in the early evening. Exercise with predominantly neuromotor and cognitive components depend also on the underlying sleep-wake cycle. Some performance measures are subject to ultradian cycles and show a transient decline in the early afternoon. Optimal time of day for exercise is determined not just by endogenous rhythms but also by the nature and intensity of exercise, the population concerned,
environmental conditions, and individual phase types. It was concluded that, the existence of self-sustaining rhythms should be recognized by athletic practitioners, sports scientists concerned with experimental work and fitness testing, sports injury specialists, and sports organizers concerned with the travel plans of athletes.

Hill, Hill, Fields & Smith (1993) evaluated the effects of jet lag on factors associated with sport performance. Members of the USA Women’s Soccer Team traveled to Taiwan and also North American students and faculty traveled to Western Europe; and in Study 3, European students traveled to North America. After travel, there was disruption of mood state and a reduction in dynamic strength; peak 5-s power and 30-s work capacity were reduced for 2 days. It was concluded that, mood state, anaerobic power and capacity, and dynamic strength were affected by rapid transmeridianal travel, and even highly trained athletes suffered from jet lag.

Maroulakis and Zervas (1993) examined whether participation in an aerobics class produces an enhancement in the mood state of exercising women, and whether any effects persist 24 hours later, and (c) whether exercising in the morning or in the afternoon leads to differential effects. 99 women, aged 19 to 55 years, participated. Of 77 members of a fitness club who formed the treatment group, 28 exercised in the morning and 49 in the afternoon. The control group consisted of 22 nonexercising female clerks. The Profile of Mood States was administered just prior to and immediately after an aerobics
class, as well as approximately 24 hours later. Members of the control group completed the Profile at their workplaces, following an identical time pattern. Analysis indicated a significant beneficial effect of exercise at both times of day on all dimensions of mood. 24 hours later, mood scores had not fully regressed to pre-exercise levels. The control group's over-all mood profile was poorer and their responses remained basically unaltered across administrations.

Byrne and Byrne (1993) addressed the current literature related to investigations of the link between exercise treatments and depression, anxiety and other mood states. Results from these investigations are supportive of the anti-depressant, anti-anxiety and mood enhancing effects of exercise programs. There were considered to be, however, a number of potential methodological problems in many of the research studies; the nature of these were considered. Finally, some possible directions for future research are outlined.

Kaciuba-Uściłko, Porta, Nazar, Tonderska & Titow Stupnicka (1994) determined whether a negative shift in subject's mood alters cardio-respiratory and endocrine responses to exercise, 20 young men performed a graded bicycle ergometer test (50, 100, 150 W): 1) when they experienced a mixed emotional and cognitive stress before exercise (1st session), 2) when they were familiarized with the laboratory and rested quietly before exercise (2nd session). The subjects' mood was assessed by the Profile of Mood State (POMS) questionnaire. In the 1st session the subjects started exercise with
significantly higher scores of tension, anger, depression, confusion and global mood in comparison with the 2-nd session. In conclusion, a mild psychological stress, causing the mood worsening before standard exercise test, does not evoke pronounced alterations in cardio-respiratory responses to exercise in healthy men, but it does affect the magnitude of exercise-induced changes in both plasma free and total noradrenaline concentrations.

Yamada & Takahashi (1994) evaluated biological rhythm disturbances in affective disorders. Affective disorders are characterized by rhythmic disturbances: early morning awakening, diurnal variations in mood, and periodic and seasonal recurrence of episodes. The free-running hypothesis of cyclic mood disorders, or the phase advanced hypothesis, phase instability hypothesis, and reduced amplitude hypothesis of depression were formulated to explain a variety of clinical and physiological phenomena found in affective disorders. A new therapy such as chronotherapy has been developed according to the hypothesized mechanisms of biological disturbances. Furthermore, antidepressant effects of antidepressants, sleep deprivation, and phototherapy have been discussed from a chronobiological point of view.

Trine and Morgan (1995) discussed influence of time of day on psychological responses to exercise. The extent to which psychological variables, such as perception of effort, mood states and anxiety, are subject to circadian rhythms at rest and during exercise, is not as well
understood. It was concluded that, circadian rhythms of perceived exertion and mood states are equivocal and the limited research on anxiety suggests that the anxiolytic response to exercise is not influenced by time of day.

Hesselmann, Neumeister, Praschak-Rieder, Bailer & Kasper (1996) studied hormonal and psychometric reactions to TD in a double-blind placebo-controlled balanced cross-over design in 12 drug-free patients with seasonal affective disorder (SAD). Patients were in stable remission induced by light therapy. Blood samples were obtained one day and 30 minutes before as well as 5 and 7 hours after TD. Conclusively our results indicate that TD might influence neurohormonal systems as well as the serotonergic system. Moreover during TD we were able to describe a coincidence of depressive symptoms, a decrease in plasma cortisol level and a raise in prolactin concentration.

Dinges et al (1997) determined cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. Cumulative changes in measures of waking neurobehavioral alertness, 16 healthy young adults had their sleep restricted 33% below habitual sleep duration, to an average 4.98 hours per night for seven consecutive nights. Subjects slept in the laboratory, and sleep and waking were monitored by staff and actigraphy. Three times each day (1000, 1600, and 2200 hours) subjects were assessed for subjective sleepiness
(SSS) and mood (POMS) and were evaluated on a brief performance battery that included psychomotor vigilance (PVT), probed memory (PRM), and serial-addition testing. Once each day they completed a series of visual analog scales (VAS) and reported sleepiness and somatic and cognitive/emotional problems. These findings suggest that cumulative nocturnal sleep debt had a dynamic and escalating analog in cumulative daytime sleepiness and that asymptotic or steady-state sleepiness was not achieved in response to sleep restriction.

Monk et al (1997) explored the relationship between circadian performance rhythms and rhythms in rectal temperature, plasma cortisol, plasma melatonin, subjective alertness and well-being. Seventeen healthy young adults were studied under 36 h of 'unmasking' conditions during which rectal temperatures were measured every minute, and plasma cortisol and plasma melatonin measured every 20 min. Hourly subjective ratings of global vigour (alertness) and affect (well-being) were obtained followed by one of two performance batteries. On odd-numbered hours performance (speed and accuracy) of serial search, verbal reasoning and manual dexterity tasks was assessed. On even-numbered hours, performance (% hits, response speed) was measured at a 25-30 min visual vigilance task. Performance of all tasks (except search accuracy) showed a significant time of day variation usually with a nocturnal trough close to the trough in rectal temperature. Performance rhythms appeared not to
reliably differ with working memory load. Within subjects, predominantly positive correlations emerged between good performance and higher temperatures and better subjective alertness; predominantly negative correlations between good performance and higher plasma levels of cortisol and melatonin. Temperature and cortisol rhythms correlated with slightly more performance measures (5/7) than did melatonin rhythms (4/7). Global vigour correlated about as well with performance (5/7) as did temperature, and considerably better than global affect (1/7). In conclusion: (1) between-task heterogeneity in circadian performance rhythms appeared to be absent when the sleep/wake cycle was suspended; (2) temperature (positively), cortisol and melatonin (negatively) appeared equally good as circadian correlates of performance, and (3) subjective alertness correlated with performance rhythms as well as (but not better than) body temperature, suggesting that performance rhythms were not directly mediated by rhythms in subjective alertness.

Ruth Benca et al (1997) evaluated sleep and mood disorders. Mood disorders are found in one-third to one-half of patients with chronic sleep problems. Likewise, most patients with mood disorders experience insomnia, but a minority obtain significantly increased amounts of sleep. Although mood disorders cause significant morbidity and mortality, they often go undiagnosed. Attention to sleep complaints could lead to better identification of mood disorders. Management of sleep problems in patients with mood disorders
should focus on treating underlying mood disorders with attention to the nature of the sleep complaint. Patients with depression show characteristic abnormalities in sleep continuity, slow-wave sleep and REM sleep patterns. Differences in sleep patterns cannot reliably distinguish patients with depression from those with other psychiatric disorders, but sleep changes may provide a window on neurobiological abnormalities in depression.

Koltyn, Lynch & Hill. (1998) examined whether psychological responses to exhaustive exercise would vary if the exercise was performed in the AM or PM. Sixteen men completed the State-Trait Anxiety Inventory and the Profile of Mood States before and following two exhaustive exercise sessions in the AM (0630-0930h) and the PM (1700-2000h). Data were analyzed with a 2 (condition = incremental, constant) x 2 (time of day = AM, PM) x 2 (trial = pre, post) repeated measures ANOVA. It is concluded that anxiety and mood responses to brief exhaustive cycling exercise are similar whether the exercise is performed in the morning or evening.

Meney, Waterhouse, Atkinson, Reilly & Davenne (1998) investigated the effect of one night’s sleep deprivation on temperature, mood, and physical performance in subjects with different amounts of habitual physical activity. On one occasion (control, C), they slept (night 1) and then underwent a battery of tests at 4 h intervals from 06:00 day 1 to 02:00 day 2; then, after a normal sleep (night 2), they were tested from 10:00 to 22:00 on day 2. On the second occasion
(sleep deprivation, SD), the subjects remained awake during night 1. Each battery of tests consisted of measurements of tympanic membrane temperature, profile of mood states (POMS), muscle strength, self-chosen work rate (SCWR), perceived exertion, and heart rate (HR) while exercising on a stationary cycle ergometer. These results stress the considerable interindividual variation in the responses to sleep loss and, therefore, the difficulty associated with giving general advice to individuals about work or training capability after sleep loss.

Cardinali (2000) discussed the influence of human circadian. Circadian clock mechanisms involve periodic gene expression, synchronized by a hierarchically superior structure located in mammals in the hypothalamic suprachiasmatic nuclei. Cycles of sleep and wakefulness are the most conspicuous circadian rhythm. Since modern humans use artificial light to extend their period of wakefulness and activity into the evening hours, they adhere to a shortnight sleep schedule with a highly consolidated and efficient sleep. A mood disorder involving a recurring autumn or winter depression (seasonal affective disorder, SAD) is related to latitude, with the number of cases increasing with distance from the equator. SAD is ameliorated by using brilliant light. In nonseasonal depression, mood typically fluctuates daily, with improvement over the course of the day, and various physiological functions exhibit an altered circadian pattern, suggesting a link with circadian disruption.
Treatment of circadian rhythm disorders, whether precipitated by intrinsic factors (e.g., sleep disorders, blindness, mental disorders, aging) or by extrinsic factors (e.g., jet lag, shift work) has led to the development of a new type of agents called "chronobiotics," among which melatonin is the prototype.

Piggins (2002) discussed human clock genes. Rhythmic variations in physiological and behavioural processes are mediated by both endogenous and exogenous factors. Endogenous factors include self-sustaining biological pacemakers or clocks which in the absence of strong external influences self-sustain periodic rhythms in such diverse physiological and psychological processes as core body temperature, food intake, cognitive performance and mood. Clocks with endogenous periods near or at 24 h (called circadian clocks from the Latin, circa dies, meaning about one day) have been documented from prokaryotes to single cell eukaryotes to multi-cellular, complex animals such as flies, rodents and humans. Over the past few years, a revolution in the understanding of the molecular basis of these clocks has led to the identification of a number of core clock genes and their proteins, and the development of elegant feedback models to explain the molecular gears of circadian clocks. At least eight human orthologs of mouse core clock genes have been identified, and polymorphisms in two of these, hClock and hPer2, have been implicated in human sleep disorders. Remarkably, knowledge of these core clock genes and the development of sophisticated reporter
systems to monitor clock gene promoter activity have led to the astonishing observation that our body is actually composed of millions of cellular clocks and oscillators whose co-ordinated activity gives rise to pronounced daily, monthly, and seasonal rhythms in physiology and behaviour. An idea that is gaining favour is that our physical and mental well-being is probably determined by the appropriate phasing of these millions of cellular clocks with recurring, meaningful events in the environment.

Cermakian & Boivin (2003) investigated a molecular perspective of human circadian rhythm disorders. A large number of physiological variables display 24-h or circadian rhythms. Genes dedicated to the generation and regulation of physiological circadian rhythms have now been identified in several species, including humans. These clock genes are involved in transcriptional regulatory feedback loops. The mutation of these genes in animals leads to abnormal rhythms or even to arrhythmicity in constant conditions. In this view, and given the similarities between the circadian system of humans and rodents, it is expected that mutations of clock genes in humans may give rise to health problems, in particular sleep and mood disorders. Here we first review the present knowledge of molecular mechanisms underlying circadian rhythmicity, and we then revisit human circadian rhythm syndromes in light of the molecular data.

Linkowski (2003) evaluated neuroendocrine profiles in mood disorders. The neuroendocrine window into the brain has been
considered as a fruitful and promising approach to the study of mental disorders, as suggested by studies of some neuroendocrine challenge tests in depression that demonstrated their potential use as biological markers. Twenty-four-hour hypersecretion of cortisol, diurnal hypersecretion of growth hormone, and normal 24-h levels of prolactin have been reported in careful chronobiological studies of depressed patients, along with sleep recordings. After successful treatment with antidepressants, most of these abnormalities tend to correct. In conclusion, a disorder of circadian time-keeping seems to characterize acute episodes of major endogenous depression in some patients.

Sher (2004) discussed the treatment of seasonal and nonseasonal mood disorders. Alcohol may adversely affect the development of suprachiasmatic nuclei (SCN), the master circadian pacemaker. Multiple research reports suggest that abnormalities in circadian rhythms are involved in the etiopathogenesis of seasonal affective disorder (SAD), a syndrome in which depression develops during autumn or winter and remits the following spring or summer. Several lines of evidence suggest that changes in the circadian system are also involved in the development of nonseasonal mood disorders, such as major depression and bipolar disorder. Thus, developmental alcohol exposure produces subtle abnormalities in circadian rhythms that may contribute to the development of seasonal and nonseasonal mood disorders. Pharmacological, psychological, and light treatments
of mood disorders have multiple effects on circadian function. The result show that, effects of many psychotropic medications depend on the time of administration in relation to body rhythmicity. Therefore, subtle circadian rhythm abnormalities related to developmental alcohol exposure may affect treatment response in patients with mood disorders.

Brigitte Kudielka, Nicole Schommer, Dirk Hellhammer & Clemens Kirschbaum (2004) investigated acute HPA axis responses, heart rate, and mood changes to psychosocial stress (TSST) in humans at different times of day. All subjects were confronted with the Trier Social Stress Test (TSST) either in the morning or in the afternoon. The total sample consisted of 180 adults with 115 younger (49 females, 66 males) and 65 older adults (32 females, 33 males). The finding that the TSST-induced mood change was differentially affected by time of day requires further exploration and comparable HPA axis and heart rate stress responses to psychosocial stress can be measured in the morning and afternoon.

Drust, Waterhouse, Atkinson, Edwards & Reilly (2005) discussed that there is a wealth of information from both applied and experimental work, which, when considered together, suggests that sports performance is affected by time of day in normal entrained conditions and that the variation has at least some input from endogenous mechanisms. Nevertheless, precise information on the relative importance of endogenous and exogenous factors is lacking.
No single study can answer both the applied and basic research questions that are relevant to this topic, but an appropriate mixture of real-world research on rhythm disturbances and tightly controlled experiments involving forced desynchronization protocols is needed. Important issues, which should be considered by any chronobiologist interested in sports and exercise, include how representative the study sample and the selected performance tests are, test-retest reliability, as well as overall design of the experiment.

Alessandro Serretti et al (2005) investigated the possible effect of the 3111 T/C circadian locomotor output cycles kaput (CLOCK) gene polymorphism on insomnia symptomatology during antidepressant treatment. One hundred seventy-eight inpatients were treated with fluvoxamine 300 mg/day (n = 147) or paroxetine 20-40 mg/day (n = 31), and either placebo or pindolol in a double blind design for 6 weeks. The severity of depressive symptoms was weekly assessed with the Hamilton Rating Scale for Depression (HAM-D). Overall, our findings may suggest that CLOCK genotype influences the time course of insomnia during antidepressant treatment.

McMorris et al (2006) examined the effect of recovery on cognition and mood. Following recovery, the performance of the central executive task was poorer than pre-treatment. Mood states, catecholamines and 5-hydroxytryptamine concentrations returned to pre-treatment values, but cortisol fell to a level significantly lower. Regression correlations showed that Delta adrenaline and Delta
scores, post-recovery, on the central executive task were significantly correlated. Delta noradrenaline correlated significantly with Delta fatigue. It was concluded that heat stress results in deterioration in the performance of central executive tasks and perceptions of mood state, and that this can be predicted by changes in body mass loss and plasma concentrations of the hormones cortisol and adrenaline.

Wirz-Justice (2006) discussed circadian biology has revealed the molecular basis of 24-h rhythmicity driven by ‘clock’ genes, as well as the importance of zeitgebers (synchronisers). Winter depression was first modelled on regulation of animal behaviour by seasonal changes in daylength, and led to application of light as the first successful chronobiological treatment in psychiatry. Light therapy has great promise for many other disorders and, importantly, as an adjuvant to antidepressant medication in major non-seasonal depression. The pineal hormone melatonin is also a zeitgeber for the human circadian system, in addition to possessing direct sleep-promoting effects. Chronobiology has provided efficacious non-pharmaceutical treatments for mood disorders (such as sleep deprivation or light therapy) as well as novel approaches to new drugs (e.g. agomelatine).

McClung (2007) suggested that abnormalities in circadian rhythms may underlie the development of mood disorders such as bipolar disorder (BPD), major depression and seasonal affective disorder (SAD). There is also reason to suspect that many of the mood stabilizers and antidepressants used to treat these disorders may
derive at least some of their therapeutic efficacy by affecting the circadian clock. Recent genetic, molecular and behavioral studies implicate individual genes that make up the clock in mood regulation. As well, important functions of these genes in brain regions and neurotransmitter systems associated with mood regulation are becoming apparent.

Colleen & McClung (2007) determined Circadian rhythms and the genes that make up the molecular clock have long been implicated in bipolar disorder. Genetic evidence in bipolar patients suggests that the central transcriptional activator of molecular rhythms, CLOCK, may be particularly important. Chronic administration of the mood stabilizer lithium returns many of these behavioral responses to wild-type levels. These findings establish the Clock mutant mice as a previously unrecognized model of human mania and reveal an important role for CLOCK in the dopaminergic system in regulating behavior and mood.

Lockley, Dijk, Kosti, Skene & Arendt (2008) quantified whether variations in waking function experienced by blind people living in society were dependent on the phase relationship between the sleep-wake cycle and the circadian pacemaker. The time course of alertness, mood and performance was assessed in 52 blind subjects with and without circadian rhythm disorders every 2 h for 2 days per week for 4 weeks. Sleep-wake timing and circadian phase were assessed from diaries and weekly measurements of urinary 6-sulphatoxymelatonin
rhythms, respectively. It was concluded that, the internal phase relationship between sleep-wake behaviour and the circadian melatonin rhythm in entrained subjects contributed to predictable differences in the daily profile of alertness, mood and performance. Disruption of this phase relationship in non-entrained blind individuals with circadian rhythm sleep disorders resulted in impaired waking function during the day equivalent to that usually only experienced when awake during the night.

Reinberg and Ashkenazi (2008) determined Internal desynchronization of circadian rhythms. Intolerance to shift work may result from individual susceptibility to an internal desynchronization. Some shift workers (SW) who show desynchronization of their circadian rhythms (e.g., sleep-wake, body temperature, and grip strength of both hands) exhibit symptoms of SW intolerance, such as sleep alteration, persistent fatigue, sleep medication dependence, and mood disturbances, including depression. The results suggest that non-tolerant SW are particularly sensitive to the internal desynchronization of their circadian time organization.

Le Strat, Ramoz, and Gorwood (2008) described Disruptions of circadian rhythms in affective disorders, including unipolar and bipolar disorder, but also seasonal affective disorder. Depression could be conceptualized as a desynchronization between the endogenous circadian pacemaker and the exogenous stimuli, such as sunlight and social rhythms. Accordingly, Clock genes have been
studied and the literature suggests that variants in these genes confer a higher risk of relapse, more sleep disturbances associated with depression, as well as incomplete treatment response. The result suggested that, some psychosocial interventions are specifically focusing on social rhythms, particularly in bipolar disorder, in which the promotion of stabilization is emphasized.

Germain & Kupfer (2008) reviewed progress in understanding the mechanisms that underlie circadian and sleep rhythms, and their role in the pathogenesis and treatment of depression. Literature was selected principally by Medline searches, and additional reports were identified based on ongoing research activities in the authors' laboratory. It was concluded that, recent progress in understanding chronobiological and sleep regulation mechanisms may provide novel insights and avenues into the development of new pharmacological and behavioral treatment strategies for mood disorders.

Hampp et al (2008) established a molecular link between the circadian-clock mechanism and dopamine metabolism, we analyzed the murine promoters of genes encoding key enzymes important in dopamine metabolism. We find that transcription of the monoamine oxidase A (Maoa) promoter is regulated by the clock components BMAL1, NPAS2, and PER2. It was concluded that, a role of circadian-clock components in dopamine metabolism highlighting a role of the clock in regulating mood-related behaviors.
Wirz-Justice (2008) investigated an individual’s pattern, regularity, relation to clinical state, and clinical improvement reveals little homogeneity. Morning lows, afternoon slump, evening worsening—all can occur during a single depressive episode. Mood variability, or the propensity to produce mood swings, appears to be the characteristic that most predicts capacity to respond to treatment. It was concluded that, the implications for treatment are to stabilize mood state by enhancing synchronization of the sleep-wake cycle with the biological clock.

Palmiero Monteleone & Mario Maj (2008) described the molecular and genetic mechanisms regulating the endogenous clock system and reviews selected studies describing circadian abnormalities in patients with depression. Evidence is emerging that a disruption of the normal circadian rhythmicity occurs at least in a subgroup of depressed patients and that interventions able to resynchronize the human circadian system, including sleep deprivation, light therapy and drugs specifically acting on the endogenous clock system, have proven antidepressant effects. It was concluded that, circadian clock system will be fruitful for a deeper understanding of the etiopathogenesis of mood disorders and the development of more effective therapeutic strategies.

Kálmán & Kálmán (2009) discussed the recent advances in the chronobiology research from the point of the clinician with particular emphasis on the psychobiology and pharmacotherapy of the
depression. Chronobiological problems are always present as aetiological or pathoplastic conditions almost in all psychiatric disorders and considered as the greatest contributors to the mood and sleep disorders associated problems. Human behaviour builds up from different length of circadian, ultradian and seasonal rhythms, strictly controlled by a hierarchical organisation of sub-cellular, cellular, neuro-humoral and neuro-immunological clock systems. Beside the biological factors, social interactions are also considered as important regulators of the biological clock systems. The pacemaker centers of the SCN receive efferents from the serotonergic raphe nuclei in order to regulate stress responses and neuroimmunological functions. The result showed that, the recently marketed agomelatine with a highly selective receptor binding profile (MT1 and MT2 agonism and 5HT2C antagonism) targets the desynchronised circadian rhythm in affective disorders and it has mainly antidepressive effect.

Kripke, Nievergelt, Joo, Shekhtman, & Kelsoe (2009) explored whether circadian gene polymorphisms were associated with affective disorders in four complementary studies. Four groups of subjects were recruited from several sources: 1) bipolar proband-parent trios or sib-pair-parent nuclear families, 2) unrelated bipolar participants who had completed the BALM morningness-eveningness questionnaire, 3) sib pairs from the GenRed Project having at least one sib with early-onset recurrent unipolar depression, and 4) a sleep clinic patient group who frequently suffered from depression. Working mainly with
the SNPlex assay system, from 2 to 198 polymorphisms in genes related to circadian function were genotyped in the participant groups. Associations with affective disorders were examined with TDT statistics for within-family comparisons. It was concluded that, along with anti-manic effects of lithium and the antidepressant effects of bright light, these findings suggest that perturbations of the circadian gene network at several levels may influence mood disorders, perhaps ultimately through regulation of MAOA and its modulation of dopamine transmission.

Pereira, Tufik & Pedrazzoli (2009) reviewed the molecular chronobiology studies in the last 36 years in order to point out the advances in this area to health professionals. We searched in the PubMed and Scopus data banks for articles related with human molecular chronobiology. It was concluded that, the development of these studies in molecular chronobiology can be helpful to treat circadian and mood disorders and to prevent health risks caused by intercontinental flights (Jet Lag), nocturnal or shift work schedule.

Murray et al (2009) discussed the circadian system modulates reward motivation. Existing literature on reward motivation pays scant attention to the fact that reward potential of the environment varies dramatically with the light/dark cycle. Evolution, by contrast, treats this fact very seriously: In all species, the circadian system is adapted to optimize the daily rhythm of environmental engagement. It is concluded that the circadian system modulates reward activation,
Kenneth et al. (2002) studied the relationship between alertness performance and body temperature in humans. The findings of their research demonstrated a positive relationship between body temperature and performance while controlling for circadian phase and hours awake. The results indicated that within the normal circadian range of body temperature, higher body temperature represented physiological arousal that enhanced neurobehavioral and cognitive functioning involving performance measures such as working memory, subjective alertness, and visual attention. Another study conducted by Holland et al. (1985) determined the effects of raised body temperature on reasoning, memory, and mood. Participants were tested for memory registration and recall. The results of this study showed that increase in core temperature was associated with a significant increase in the speed of performance of the tests, by 11 and 10%, respectively.

**Findings of Literature Review**

It is clear from the above literature that circadian rhythms are studied extensively and most of the literature available focuses on some primary circadian rhythms such as the core temperature, sleep-wake rhythms, hormonal rhythms, performance and the skin temperature in relation to cognitive and autonomic functioning in
individuals. However, there is no literature available on the circadian rhythm and its impact on the psychomotor and mood states in individuals or the degree of impact of circadian rhythms on trained and untrained men. This study aims at improving the performance of participants by determining the effect of the circadian rhythm on the psychomotor and profile of mood states. In addition, the study will try to determine whether individuals have a common circadian rhythm pattern or each individual has a unique pattern. Another goal of this study will be to identify how the circadian rhythm affects our day-to-day performance physically and mentally, and whether the impact of circadian rhythm on the mental and physical performance in trained and untrained men differs or is the same.