Chapter II

REVIEW OF RELATED LITERATURE

The research scholar has made his sincere effort to locate the literature related to this study from the libraries of Lakshmibai National College of Physical Education, Gwalior, Netaji Subhas National Institute of Sports, Patiala, and Hanuman Vyayam Prasarak Mandal's, Degree College of Physical Education, Amravati and found some of the important studies pertaining to the study undertaken, have been cited in this chapter.

Wright\(^1\) conducted a test on factors influencing diurnal variations of strength of grip. Thirtyfive subjects were involved in his study. Grip strength was measured at intervals throughout the day by an independent observer. Three groups were measured with each hand. There was a marked increase in the strength of grip from 6.00 am. to 9.00 am. or 10.00 am., sometimes a more gradual increase from them to 12.00 noon or 1.00 pm., and a great increase at night.

Marshal\(^2\) in one of his article has referred to survey made in Great Britain on workers who regularly changed from

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day to night jobs. It showed that only twenty-five percent of them could make this switch in less than five days at lafa jette clinic in Detroit. On examination of people who has lost four or five nights of sleep, disclosed that there were great changes in metabolism and greatest of them occurred among the older folks. They had become irretable, sometimes they were light hearted.

Colquhon\textsuperscript{3} conducted a study to see the performance at certain task continuously during different shifts in the laboratory over period of twelve consecutive days. It was found that, in general mental efficiency followed the course of body temperature rhythm whether or not the latter was altering as a result of adjustment to the new sleep waking routine imposed by working at usual hours on 'Night Shift' this alternation consisted primarily of a flattening of the rhythms particularly during that part of it coinciding with work spell. The flattening was accompanied by a parallel disappearance of the non-shifting of shift decrement in performance, evident in the first part of the trial period.

Herring\textsuperscript{4} conducted a survey with forty male swimmers aged 10 to 20 years. Swimmers were divided into four groups.


\textsuperscript{4}F. Vincent Herring, "Biorhythm in Swimming," \textit{Swimming Technique} 8:3 (October 1971) : 74.
Daily logs were kept and comparison made with the bio-charts. The logs contained daily times as well as comments on how the swimmers feels.

Group A, had their biorhythm calculated in advance both the coach and swimmers discussed the swimmers position on the charts.

Group B, had the bio-rhythm calculated in advance only the coach was aware of the swimmers position on the charts.

Group C, had their biorhythm calculated in advance. The swimmers kept back of their own biorhythm.

Group D, did not calculated their biorhythm until the end of season, when they compared their biorhythm charts with daily logs.

No significant difference in the result of four group was found, therefore, ruling out the power of suggestion. Although in three groups, the coach and swimmers was aware of their biorhythm positions before practice, no attempt was made to alter the training to fit the cycle.

Ansorge\textsuperscript{5} conducted a study on the effect of time of day and temperature variations upon selected physical performance

test. The subjects were 108 male college freshmen or sophomore students who were in the spring semester of 1969-70, enrolled in classes in the physical education skill programme at the university of Iowa.

1. For the initial test period a significant difference in favour of 75°F group mean over the 65°F group mean was found for the reaction time test.

2. For the initial test and retest periods a significant difference in favour of the 85°F group mean over the 65°F group mean was found for the forearm flexion strength test.

3. The over all means for test of forearm flexion strength, reaction time, and arm-movement time significantly improved from the initial test period to the re-test period.

4. For the standing broad jump test, none of the main effect of test, times, or temperature was significant, nor was any of the intereactions.

5. For the initial adjustment period, the main effect of testing room temperature and the main effect of time of day on oral temperature and mean skin temperature were significant. More over, the main effect of testing room temperature pulse rate was significant.
Lobben\textsuperscript{6} studied a group of human subjects who were in a strictly defined routine in which time, nutrition, rest, work were very well controlled. The result of this study showed that the rate of exertions of water, potassium, sodium and chloride were substantially greater during the hours of the normal working day than during the hours of rest.

Venkateswarlu\textsuperscript{7} observed the diurnal changes in physiological performance. He took twentyfive male students undergoing training in National Institute of Sports, Patiala. Performance was evaluated by Harward Step test at different time. The result of his study showed significant differences in performance level produced at different times during a 2 hours period.

Osteberg\textsuperscript{8} studied circadian rhythm of food intake and oral temperature in "morning" and "evening" group of individual. "Morning" and "evening" type in a psychology class were identified by means of a questionnaire, and asked to record their oral temperature and food intake throughout the day during a four week and four day periods respectively. The morning group had


its mean circadian temperature maximum five hours earlier than the evening group and had its cumulative food intake distribution curve 1-3/4 hours in the time base to get a least squarefeet significant difference between the distribution remained. It is suggested that morning type have more autonomous 24 hours periodicity than evening types. It was concluded that the questionnaire have the power to discriminate extreme morning and evening types of individuals in terms of oral temperature and food intake. Foot intake comes to be a sensitive enough measures to be included in studies of inter-individual differences of circadian rhythm.

Cohen and Muehl\textsuperscript{9} conducted a study on five male students to investigate the circadian rhythmicity in resting, exercise and recovery pulse rate. Resting pulse rate data was collected at seven separate times during 24 hour period. Exercise and recovery pulse rate were collected at the exact same time as follows: 0400, 0800, 1200, 1500, 1800, 2100, and 2400 hours. Exercise pulse rate followed the same general pattern and tended to amplify the circadian rhythmicity.

Couzelis\textsuperscript{10} conducted a study on circadian variations in responses of trained and untrained men to submaximal exercise. Circadian variation of the cardio-respiratory system were studied during eleven minute bout of submaximal (50 per cent $V\text{O}_2\text{max}$) bicycle ergometer exercise performed every three hours for 24 hours by eight matched group of three subjects. Blood pressure, pulse pressure, tidal volume, blood lactate, serum potassium, and perceived exertion demonstrated significant ($P < .05$) circadian rhythm when analysed by the cosinor procedure. ANOVA revealed time dependent differences during exercise in $V\text{O}_2$, $R$, Pulse pressure, and blood lactate. No evidence at noon exerts a meaningful exogenous influence on the timing to circadian rhythms. Results indicate that in studies where cardio-respiratory parameters are measured during exercise, attention must be paid to the circadian phase during which the subjects are measured.

Smith\textsuperscript{11} investigated the circadian variations, in human temperature regulations, peripheral and rectal temperatures and peripheral heat and arterial blood flows were measured in clothed resting males in a neutral environment at different times throughout


the day. Core periphery heat conductance was considered a measure of thermo-regulatory functions and was used together with peripheral heat and blood flows, inevaluating changes in this function circadian thermo-regulation changes were isolated from response to environmental stresses variously by bed rest procedures by use of conventional statistics and by periodicity analysis following Halberg's method. The results so obtained indicated that circadian changes do occur in all thermo-regulatory functions measured and that a possible mechanism for these variations may be circadian change in circulatory pathways and so encounter heat exchange, as well as circadian variations in peripheral blood supply.

Belowich and Sachs\textsuperscript{12} examined the relationship of biorhythm to the swimming performance of 21 members of the Florida State University Men's Swimming Team. Two scales (A and B) were used to measure position on the three biorhythm cycles (physical, emotional and intellectual). These were compared with two types of performance evaluation. A coach's subjective evaluation of swimming performance (on a rating scale of 1-7), and B objective performance evaluation consisting of average times for a set of 10x50 yard swim on a 45 second send off. Comparison among the biorhythm and the performance measures were made using

multiple regression analysis.

Results were generally not supportive of biorhythm theory. A qualitative evaluation of plots of raw data and the estimate obtained from the regression analysis revealed 17 of the 21 swimmers 81 per cent to have graphs indicative of relationship between biorhythms and the evaluation and performance. However, only 15 of the swimmers were in agreement for the qualitative evaluation by both authors. The qualitative evaluation, employing the significance of the $R^2$ values obtained, revealed that only 43 per cent of the swimmers (on scale A: 33 per cent on Scale B) demonstrate a significant relationship between biorhythm and performance on the 10x50 yard swims. A significant relationship between biorhythm and coaches evaluation was obtained for 57 per cent of the swimmers on swimmers (on scale A; 67 per cent and scale B).

Quigley\textsuperscript{13} studied "biorhythms" and men's track and field world records. He claims that athletic performance, like human behaviour are governed by their invariant "biorhythms" were tested for all men's metric world records in track and field from 1913 to 1977 ($N = 700$). Outstanding performance are said to occur during positive cycle phases; and poor performances, error of

judgement, and accidents, during the negative phases and particularly at crossover points (critical days). "Biorhythm" amplitudes were calculated, and a chi-square analysis was used to compare the frequencies of records occurring in the positive, negative, and critical phases of each cycle with a random model. The phase distribution of records within each individual cycle fit the random model ($X^2 \leq 2.22$, $P > 0.30$). The combined effect of three cycles, determined from the means "biorhythm" amplitude ($X^2 = 1.30$, $P > 0.20$) and the number of cycles in each phase ($X^2 = 3.50$, $P > 0.30$), also showed no significant departure from the expected from the number of critical days in each cycle ($X^2 = 3.37$, $P > 0.15$). These data reinforce our previous study on Australia records and the performance of acceptable published research into sports, accidents, and medical data in that they provide no evidence of the existence or effects of "biorhythm".

Reilly\textsuperscript{14} conducted a longitudinal study ($N = 37$) over 36 weeks was employed using a single subject design for effective control of major zeitgebers in the nychthemeron. Results suggest that the periodicity in ventilation is partially independent of the oscillator linking body temperature and metabolic rate. Its persistence in submaximal exercise has only minor repercussions for

cellular respiration, it is concluded that circadian rhythms in VO2 are relatively unimportant in affecting the rate and levels of adaptation to moderate work loads, the more robust VE cycle contribute to the greater discomfort associated with nocturnal exercise without any alteration in muscular efficiency.

Zani et al.15 conducted a study on diurnal interindividual differences in the habitual activity pattern of top level athletes. The athletes occupied the top national levels. In all a sample of 87 subjects was obtained. Means and standard deviations for the morningness - eveningness scores of the different samples of athletes are tested. As the mean age was significantly different (F 6.80 = 15.09; P < 0.01) through the athletes samples. One-way analysis of covariance, with the age as covariate and the score as dependent variate, was performed to test the differences in morningness - eveningness performances. A significant difference was found among the samples (F 6.79 = 2.6; P < 0.01). A decrease in morningness scores was evident going from golf and shooting to volleyball or waterpolo. The results of tests for simple effects (1 - test for independent samples). Results showed significant difference in the morningness - eveningness expressed preferences among athletes in agreement with their sports activity.

Reilly, Robinson and Minors\textsuperscript{16} studied some circulatory responses to exercise at different time of day. Circadian rhythms in heart rate were examined at rest, immediately pre-exercise, during submaximal and maximal exercise on a cycle ergometer, and during recovery post-exercise (N = 10) observations were made under controlled condition at 0300, 0900, 1500, and 2100 hours. A significant circadian rhythm was found for resting heart rate in lying supine and sitting pre-exercise (P < .05), peak values being measured at 1500 hours. The acrophase in the oral temperature rhythm at 1739 hours was not significantly out of phase with that of resting heart rate (P > .05). The rhythm in heart rate persisted during submaximal exercise (150 w) and at maximal rate (P < 0.05); the amplitude of the rhythm was alternated at maximum. Rating of perceived exertion at submaximal and maximal exercise intensities, and time to exhaustion on the ergometric test did not vary significantly with time of day (P > .05). The incuement of 0.2°C in oral temperature during exercise did not exhibit circadian variation (P > .05). A significant rhythm was found for recovery heart rate in minutes 2, 3, 4, and 5 post exercise (P < 0.05). Observations of systolic and diastolic pressure pre and post exercises were inconclusive. Therefore, the circadian rhythm in

heart rate responses to exercise should be considered when a heart rate variable is used as a criterion in fitness testing or as an index of physiological strain.

Hill et al.\textsuperscript{17} studied on diurnal variation in response to exercise of "morning types" and "evening types". Thirty-two college students were classified based on responses to a questionnaire, as lacks (N = 11) and owls (N = 14), or as not strongly either (N = 7). Subjects performed incremental maximal cycle ergometer tests in the am. and pm. Considered together subjects had am.-pm. differences (at $P \geq 0.01$) in resting HR (mean $\pm$ SE: -7 $\pm$ 1 beats, min. -1, or -11%), in VO$_2$ at the submaximal works rate of 100 watts (-0.11 $\pm$ 0.03 l-min.$^{-1}$ or -7%), and in VO$_2$ max (-0.11 $\pm$ 0.03 l min.$^{-1}$, or -4%). am. - pm. differences in HR, VO$_2$, and RPE during exercise at 100 watts and at the ventilatory threshold were the same in morning type and evening types. Diurnal variations (am. - pm. differences) in VO$_2$ max. of lacks and owls were different ($P < 0.05$) owls in the pm. (+4%). The owls higher VO$_2$ max was not associated with a longer performance time. Result for VO$_2$ max suggest that morning type versus evening type must be considered in studies where exercise is performed at various times of the day. However, he conclude that diurnal

\textsuperscript{17}D.W. Hill et al., "Diurnal Variation in Response to Exercise of "Morning Types" and "Evening Types", The Journal of Sports Medicine and Physical Fitness 28 (December 1988):213.
variation most responses to exercise are the same for both morning
types and evening types.

Masahiro et al.\textsuperscript{18} studied the effect of the time of the
day on forearm, arterial blood flow, both at rest and immediately
following a sustained submaximal contraction of the forearm
muscle on eight male subjects living a normal routine. Datas on
blood flow, heart rate and oral temperature were collected at
0900, 1130, 1500 and 2230 hours from subjects resting thirty
minutes prior to each experiment. Circadian pattern in both resting
forearm arterial flow, maximum post exercise flow were obtained.
The rhythm generally peaked in the late afternoon, as did the
heart rate and body temperature. Circadian variation magnitudes
were approximately 45 per cent of their means for both resting
and post exercise arterial flows. Shuffling resting levels of arterials
flow with leg negative pressure caused a decrease in all flow
levels but did not show any alteration in the circadian pattern.
The magnitude of these circadian variations appeared sufficient
to indicate a cyclic pattern in peripheral resistance in addition
to know arterial pressure rhythms.

\textsuperscript{18}Kneko Masahiro et al., "Circadian Variation in Human
Peripheral Blood Flow Levels and Exercise Responses," \textit{Journal
Hill and Smith\textsuperscript{19} conducted a study on circadian rhythm in an aerobic power and capacity. Anaerobic power and capacity were measured in nine college age men at four different times of day: 0300 hours, 0900 hours, 1500 hours, and 2100 hours. Modified wingate tests were performed against a common resistance of 5.5 kg. (0.074 ± 0.004 kg. per kg. body mass) peak power was defined as the highest power output during a 5.5 period in the test, and anaerobic capacity was defined as the total external work during the 30.5 test. Peak power tended to differ across testing times (F= 2.50, P = .10), with the mean at 2100 hours about 8 per cent higher (P < .05) then at 0300 hours. Anaerobic capacity differed across the times of day. (F = 9.58, P < .01), with the means at 1500 hours. These results suggest that there are circadian rhythms in anaerobic power and capacity.

Das and Bhomick\textsuperscript{20} conducted a study on biorhythm in physical fitness. School boys of 12+ age group were selected as a subject. He took four different times within 24 hours as criterion measures. The physical fitness was measured by AAHPER youth fitness and test battery. The different times of the day


were 8.00 am., 12.00 noon, 4.00 pm. and 8.00 pm. He came with the conclusion that the mean value of physical fitness score was highest at 4.00 pm. and lowest at 12.00 noon. Significant difference was found among the mean values of physical fitness of different times. The physical fitness score at 4.00 pm. was significantly greater than the mean value of other times viz. 8.00 am., 12.00 noon and 8.00 pm. even at .01 level. Therewas no statistical significant difference between the mean values of 12.00 noon and 8.00 am. 12.00 noon and 8.00 pm. and 8.00 am. and 8.00 pm.

Hill et al.\textsuperscript{21} conducted a study on effect of time of day on aerobic and anaerobic responses to high intensity exercise. He evaluated the effect of time of day on performance of high intensity. Constant power cycle ergometer by both men and women. Subjects performed all out cycle ergometer tests in the morning and in the afternoon in randomized order for all tests, work rate was a constant 5.0 watts kg\textsuperscript{-1} (women, n = 6) or 6.0 watts kg\textsuperscript{-1} (man, n = 8). Total work performed was 9.6\% greater in the afternoon (mean ± SE, 348.8 ± 40.6 J. kg\textsuperscript{-1}). The greater amount of work in the afternoon was associated with a 5.1 per cent higher aerobic power and a 5.6\% larger anaerobic contribution. There

was no interaction between gender and the effect of time of day on the aerobic and anaerobic contribution. There results preside evidence of a circadian rhythm in aerobic and anaerobic responses to high intensity short duration exercise, in women as well as in men.

Montelpare, Phyley and Shephard\(^{22}\) conducted a study on evaluating the influence of sleep deprivation upon circadian rhythms on exercise metabolism. The data were collected on eleven young male volunteers who had been recruited from the university community under a protocol approved by the university committee. The subjects were 22.7 ± 2.2 years of age. It is concluded that the several responses to submaximal exercise (heart-rate, respiratory minute volume, oxygen intake and rating of perceived exertion) tend to be influenced by both circadian factor and feeding that the feeding effects are the strong of two, and the regularity of both influences weakens over the course of 60 hours of sleep deprivation. Details of this changes could be explored by applying the type of analysis illustrated here to a large population sample. Given the known inter-relationship between feeding, acid-base balance, and carbon dioxide output, it might also be desirable to include such observation in future studies.

Reninberg et al. conducted a study on French International Sabre fencers. According to him, in the field of court games, players may have to play tournament matches at start time ranging from 0800 to 2200 hours. The skill of these games differ from those executed in Sabre fencing or track and field athletics and so may not share a common circadian cycle and he came out with the conclusion that the French International Sabre fencers showed that their best scores as far as they related to speed and skill, were around noon.

Reilly and Walsh conducted a study on 5-a-side soccer play sustained for four days demonstrated that the work rate of players varied rhythmically. The pace of play showed a peak at about 1800 hours and a through at 0500 - 0600 hours. Feeling of fatigue were negatively correlated with level of activity and with muscular strength. The self placed levels of exercise conformed closely to the curve in the body temperature and was not obliterated by sleep deprivation. As the rhythm applied to light exercise sustained for a supra-normal period, it does not necessarily

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indicate psychological and biological predispositions for more intensive exercise and he suggested that this requires experimental manipulation of subjects according to time of day in stimulated contests.

Conroy and Brain\textsuperscript{25} conducted a study on diurnal variation in athletic performance. It was the first systematic study of diurnal variation in performance of sportsman. He came out with the conclusion that six runners, 3 weight throwers and 3 oarsmen were found to do better in the evening than in the morning.

Rodahl et al.\textsuperscript{26} conducted a study on diurnal variation in performance of competitive swimmers. He found that swimmers produced faster times over 100 m. at 1700 hours compared with 0700 hours in 3 out of 4 stroke studied.

Baxter and Reilly\textsuperscript{27} studied the influence of time of day on all-out swimming. He took the performance of 100 m. and 400 m. at 5 times of the day between 0630 hours and 2200 hours. The time for both distance showed a linear trend, the


study improvement through the day being 3.5% for 100 m. and 2.5% for 400 m. Improvement in the evening was noted even after the body temperature had begun to decline.

Reilly and Down\textsuperscript{28} conducted a study on time of day and performance of all-out arm ergometry. He failed to find a rhythm in aerobic power or anaerobic capacity as expressed by the 30s Wingate Anaerobic Test. Subjects were well warmed-up prior to exercise and were well motivated to work all-out for its duration. In such conditions the circadian variation in power production may be less than the measurement error associated with this test. The result of the study showed that the maximal aerobic power of the arms is relatively stable function which is not significantly altered by the time of day.