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Effect of inter - individual differences in chrono type over body temperature, grip strength and selected physiological variables of college women softball players

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Abstract
The primary purpose of this study was to find the relationship between chrono type and body temperature on grip strength right hand (R), grip strength left hand (L) average grip strength (AVG), pulse rate, blood pressure (diastolic) and blood pressure (systolic). In order to achieve the above-mentioned objectives, sixteen (16) female softball team members undergoing B.Tech graduation course at College of Engineering, Thiruvanathapuram, Kerala, India were tested. The instruments used include Morningness-Eveningness in human circadian rhythms questionnaire (Horne J.A and Ostberg 1976), digital blood pressure monitor, digital Thermometer and electronic hand dynamometer. After determining the chrono type, body temperature, grip strength right (R), grip strength left (L) pulse rate, blood pressure (diastolic) and blood pressure (systolic) were recorded. ANOVA results and post-hoc test on dependent variables grip strength (R), grip strength (L) and grip strength average found no significant differences among the independent variable body temperature. The result also shows that dependent variable grip strength (Right) found having significant differences between independent variables chronotype.

Keywords: chronotype, body temperature, grip strength, blood pressure

Introduction
In field sports, players must now move quicker, foresee better, display greater levels of technical and tactical capability and persist longer than competitors from the past. The fundamentals for training and competing can no longer be based on simple subjective views of how well athletes perform or on traditional methods passed from one generation of coach to another. The word circadian rhythm comes from the Latin circa, “around”, and dies, “day” which means around a day [17] the clocks are synchronized by the 24 hours patterns of light and temperature produced by the earth’s rotation. Body temperature is a complex, non-linear variable that is subject to many sources of internal and external variation. Physical performance is directly related to productivity of body temperature therefore improved physical performance will lead to higher productivity performance. The daily pattern of body temperature is the most widely assessed circadian rhythm in chronobiological studies and considered a “marker rhythm” to determine time on an individual’s body clock and as a reference point to determine whether other rhythms are synchronized or desynchronized [4].
Present study intended to discover the influence of Inter-individual differences in chronotype and different body temperatures among the college softball women team in grip strength, pulse rate and blood pressure. Since the both these factors plays a vital role in sports man by gaining a proper understanding and the concepts involved behind these factors, will take advantage of the body’s natural rhythm to positively impact productivity during training and competition.

Methodology
Subjects
Sixteen (16) college softball players selected to participate in Kerala University inter collegiate tournaments were participated in this study. The subjects were undergoing B. Tech graduation course in College of Engineering, Thiruvananthapuram.

The age of the subjects ranged from 20 to 25 years, with a mean age of 22.5 ± 22.69. Data were collected from the ten days of coaching camp conducted.

Tools

1. Morningness-Eveningness questionnaire (MEQ)

Morningness-Eveningness questionnaire (MEQ) developed by Horne JA and Ostberg. O, (1976) to evaluate the time an individual get up and go to bed, self-reported preferred times for physical and mental activity, and also the subjective alertness. The MEQ contains total nineteen questions with Likert-type responses and four choices of answer were given, indicating; definite morning type (DMT), moderate morning type (MMT), moderate evening type (MET), definite evening type (DET) and Intermediate type (IT). Few questions, a time scale are used. This scale is clearly divided in to periods of fifteen minutes over a seven-hour time range. The scores range from 16-86. The highest scores between the 70-86 numbers indicated definite morning type (DMT) between 16-30 indicates definite evening type (DET) between 59-69 indicated moderate morning type (MMT) between 31-41 indicate moderate evening (MET) and score between the range 42-58 indicates inter mediate type (IT) neither belong to morning type (MT) nor evening type (ET). The time scales were assigned a 1-5 range, in the direction of high eveningness to high morningness.

2. Digital blood pressure monitor (DBPM)

Blood pressure (systolic, diastolic) and pulse rate reading was measured using fully automated and monitor provided (model No HEM-8712) with the specifications such as measuring method as Oscillometric system, Indication: Digital display, Range: Blood Pressure: 40-240 mm Hg, Pulse: 40-199beat/min for a duration 5 min interval for twice and record both measurements by taking the average. The apparatus is used according instruction manuals by the subject sits on a chair left arm is comfortably resting on the table. The heart, the left arm and the apparatus are in the same horizontal plane. Put the subject's arm through the cuff loops. Position the arm correctly, the bottom edge of the cuff should be 1 or 2 cm above the elbow and the marker (arrow under tube) is centred on the middle of inner arm. Cuff of the tightly wound round the upper arm and press start button to inflate the cuff automatically. After reaching the required level of inflation, the cuff will start to deflate automatically, wait for complete deflation and display shows the subject's blood Pressure (systolic and diastolic) and pulse rate.

3. Digital thermometer (Model No MT-101)

Axillary temperature was measured by inexpensive (IE) temperature devices (model no MT-101 Stupendous Handheld DT Manufacturers, based in India) used according to the method instruction manuals, placed high in the central axillary region (AR) with the subjects' right arms adducted after being wiped free of sweat. DTM ensures high durability, robust structure and accurate measurement of temperature. The display range: 32.0 to 42.0°C (90 to 107.6°F) Accuracy: ±0.1°C (±0.2°F) Minimum Scale: 0.1 Measurement time: 60 ±10 seconds in oral, 100 ±20 seconds underarm. Beeper function, auto shut-off. Capacity: 1.5V button battery (LR/SR-41) Memory: last measuring reading LCD size: 15.5 x 6.5mm Size: 127 x 18 x 10mm and Net weight: 10.5g.

4. Electronics hand dynamometer (Model No EH101)

The participants' physical strength was measured by giving them the static arm pull test using an electronics hand dynamometer model No EH101. The testing method which involved adjustment of the handle of the equipment such that the forearms of the participant were flexed at 90 degrees and the upper arms were vertical, parallel, and adjacent to the torso. The participant was required to stand erect with legs and back straight and with feet flat. The participant was the required to hold sides of the handle bar connected to the load cell and exert the force upward and vertically in the sagittal plane. The exerted force was generated by the arms only and shoulder movement was avoided. Each participant was asked to pull the handle gradually with maximum strength without jerking for duration up to 30 second and the strength readings were displayed on the gauge in kgs. The procedure was repeated three times per participant, to ensure accuracy and the average was computed.

After determining the circadian rhythm type, body temperature, grip strength right (R), grip strength left (L) pulse rate, blood pressure (diastolic) and blood pressure (systolic) were recorded on each day of coaching camp.

Procedure

Prior to the test, a meeting of all the participants were held and they were explained regarding the objectives of the study, test procedure and effort they had to put in. The necessary data was collected by administering the tests for the chosen variables.

Statistical analysis of data

All statistical analyses were conducted using SPSS (release 2.0, SPSS, Chicago, IL). ANOVA was used to determine the difference between the subjects under the study.

Results and Discussion

The data pertaining to selected variables such as relationship between chrono type and body temperature on grip strength right hand (R), grip strength left hand (L) average grip strength (AVG), pulse rate, blood pressure (diastolic) and blood pressure (systolic) were analysed by ANOVA and post-hoc test on dependent variables. The results are given in Tables 1, 2, 3, 4 & 5. The graphical representation of the mean score of the selected variables under the study are presented in the figures1, 2, 3, 4, 5, 6, 7, 8, 9 & 10.

Table 1: Descriptive statistics of dependent grip strength (L & R) and average grip strength of women softball players with body temperature

Dependent variables	Temperature (Fahrenheit)	N	Mean	Std. Deviation	Std. Error
Grip (R)	96	13	26.69	3.987	1.106
	97	87	27.62	3.948	.423
	98	76	27.50	3.995	.458
	Total	176	27.50	3.955	.298
Grip (L)	96	13	26.62	5.824	1.615
	97	87	26.02	4.215	.452
	98	76	25.78	3.890	.446

	Total	176	25.96	4.194	.316
Grip AVG	96	13	26.65	4.244	1.177
	97	87	26.82	3.868	.414
	98	76	26.63	3.575	.410
	Total	176	26.73	3.751	.282

Dependent variable grip strength (R), grip strength (L) and grip strength average (Avg) was measured at three different body temperature. The table reveals that at 96 degree Fahrenheit body temperature grip (R) was 26.69 (SD = 3.987) grip strength (L) was 26.62 (SD = 5.824). At 97 degree Fahrenheit the grip strength(R) mean score was 27.62 (SD = 3.948) that of mean score was 26.02 (SD = 4.215) and at 98 degree Fahrenheit the grip strength (R) mean score was 27.50 (SD = 3.995) that of strength mean score (L) of 25.78 (SD = 3.890) The table also reveals the grip strength average measured at three different body temperatures at 96, 97 and 98 degree Fahrenheit respectively. The grip strength (R) the mean score was 26.654 (SD = 4.245) grip strength (L) mean score was 26.822 (SD = 3.868) and degree Fahrenheit the grip strength mean score was 26.638 (SD = 3.752). The graphical representation of the mean score of body mass index between regions, are presented below in Figures 1, 2 and 3 respectively.

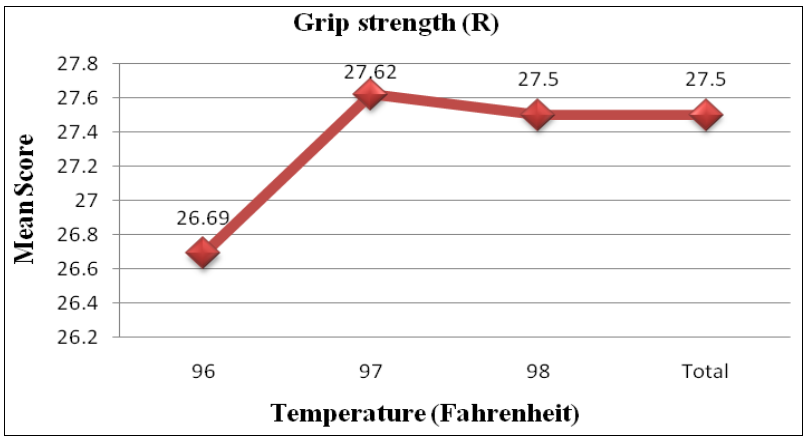

Fig 1: Marginal mean scores of grip strength right in relationship with the body temperature

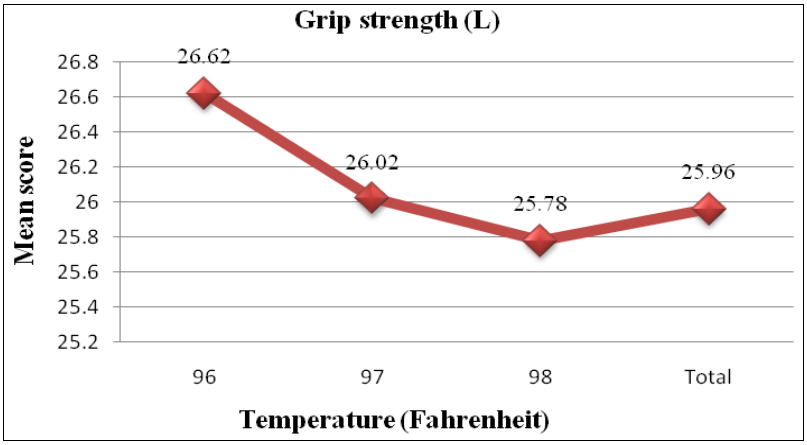

Fig 2: Marginal mean scores of grip strength left in relationship with the body temperature

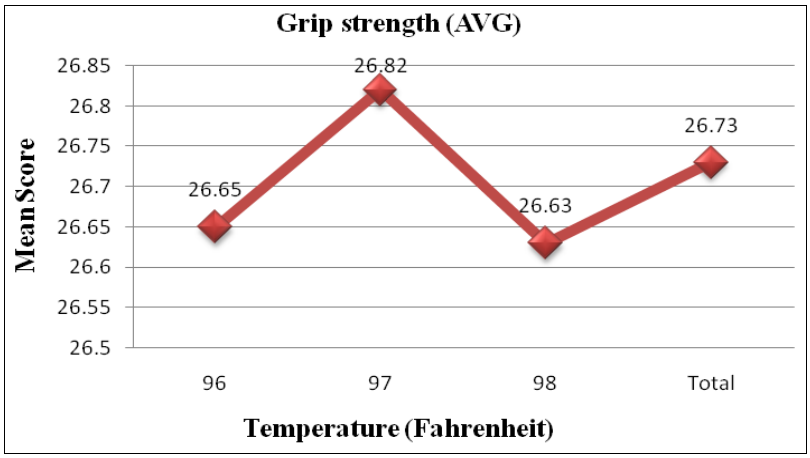

Fig 3: Marginal mean score of grip average in relationship with the body temperature

Table 2: ANOVA on body temperature with grip strength and average grip strength for the right and left hand

		Sum of squares	df	Mean square	F	Sig.
Grip (R)	Between Groups	9.748	2	4.874	.309	.735
	Within Groups	2728.252	173	15.770		
	Total	2738.000	175			
Grip (L)	Between Groups	8.493	2	4.247	.239	.787
	Within Groups	3070.228	173	17.747		
	Total	3078.722	175			
Grip AVG	Between Groups	1.450	2	.725	.051	.950
	Within Groups	2461.980	173	14.231		
	Total	2463.430	175			

*>p.05 (2.25)

Analysis of variance was performed to find out any significant difference exits between different temperatures. The results revealed that, there were no significant differences on dependent variables Grip strength (Right) (F = .309) Grip Strength (Left) (F = .239) and Grip Strength Average (F = .051) on various temperatures.

Table 3: Descriptive statistics of dependent variable grip strength, average grip strength of right and left hand, body temperature, pulse rate, blood pressure (diastolic) and blood pressure (systolic) in relationship with circadian rhythm

		N	Mean	Std. Deviation	Std. Error
Grip (R)	Definitely Morning	11	29.27	2.005	.604
	Moderate Morning	23	25.57	3.553	.741
	Moderate Evening	54	27.78	4.403	.599
	Intermediate	88	27.61	3.816	.407
	Total	176	27.50	3.955	.298
Grip (L)	Definitely Morning	11	25.55	2.382	.718
	Moderate Morning	23	24.87	5.268	1.099
	Moderate Evening	54	26.04	3.986	.542
	Intermediate	88	26.25	4.197	.447
	Total	176	25.96	4.194	.316
Grip AVG	Definitely Morning	11	27.4091	2.09545	.63180
	Moderate Morning	23	25.2174	3.83414	.79947
	Moderate Evening	54	26.9074	3.91306	.53250
	Intermediate	88	26.9318	3.74717	.39945
	Total	176	26.7301	3.75190	.28281
B T	Definitely Morning	11	97.36	.674	.203
	Moderate Morning	23	97.39	.722	.151
	Moderate Evening	54	97.37	.653	.089
	Intermediate	88	97.34	.565	.060
	Total	176	97.36	.616	.046
Pulse Rate	Definitely Morning	11	89.09	14.481	4.366
	Moderate Morning	23	89.61	16.919	3.528
	Moderate Evening	54	89.59	12.375	1.684
	Intermediate	88	85.58	14.240	1.518
	Total	176	87.56	14.110	1.064
BP (Diastolic)	Definitely Morning	11	63.45	7.751	2.337
	Moderate Morning	23	70.52	11.870	2.475
	Moderate Evening	54	65.65	12.790	1.741
	Intermediate	88	66.07	15.397	1.641
	Total	176	66.36	13.840	1.043
BP (Systolic)	Definitely Morning	11	101.00	6.914	2.085
	Moderate Morning	23	106.04	10.429	2.175
	Moderate Evening	54	102.28	13.449	1.830
	Intermediate	88	107.19	15.610	1.664
	Total	176	105.15	14.077	1.061

Depended variable grip strength (R), grip strength (L), average grip strength (AVG), body temperature (BT), pulse rate (PR), Blood pressure diastolic (BPD) and Blood pressure systolic (BPS) was measured at four different of Circadian rhythm type namely Definitely morning type, Moderate morning type, Moderate Evening type and Intermediate type. The table reveals that at definitely morning the grip (R) was 29.27 (SD = 2.005), grip (L) was 25.55 (SD = 2.382). At moderate morning the grip strength (R) mean score was 25.57 (SD = 3.553) grip strength (L) mean score was 24.87 (SD = 5.268). At moderate evening the grip strength (R) mean score was 27.78 (SD = 4.403) grip strength (L) mean score was 26.04 (SD = 3.986) and intermediate type the grip strength (R) mean score was 27.61 (SD = 3.816) grip strength (L) mean score was 26.25 (SD = 4.197). The average grip strength (AVG) the table reveals that definitely morning type the grip strength was 27.4091 (SD = 2.09545), at moderate morning type the mean score was 25.2174 (SD = 3.83414), at moderate evening type the mean score was 26.9074 (SD = 3.91306) and intermediate type the mean score was 26.9318

(SD = 3.74717). On body temperature (BT) the table reveals that definitely morning type the mean score was 97.36 (SD = .674), moderate morning type the mean score was 97.39 (SD = .722) moderate evening type the mean score was 97.37 (SD = .653) and intermediate type the mean score was 97.34 (SD = .565). On pulse rate (P R) the table reveals that definitely morning type the mean score was 89.09 (SD = 14.481), moderate morning type the mean score was 89.61 (SD = 16.919), moderate evening type the mean score was 89.59 (SD = 12.375) and intermediate type the mean score was 85.58 (SD = 14.240). The blood pressure diastolic (BPD) the table reveals that definitely morning type the score was 63.45 (SD = 7.751), at moderate morning type the mean score was 70.52 (SD = 11.870) moderate evening type the mean score was 65.65 (SD = 12.790) and intermediate type the mean score was 66.07 (SD = 15.397) and on blood pressure systolic (BPS) the table reveals that definitely morning type the mean score was 101.00 (SD = 6.914), moderate morning the mean score was 106.04 (SD = 10.429), moderate evening type the mean score was 102.28 (SD = 13.449) and at intermediate type the mean score was 107.19 (SD = 15.610).

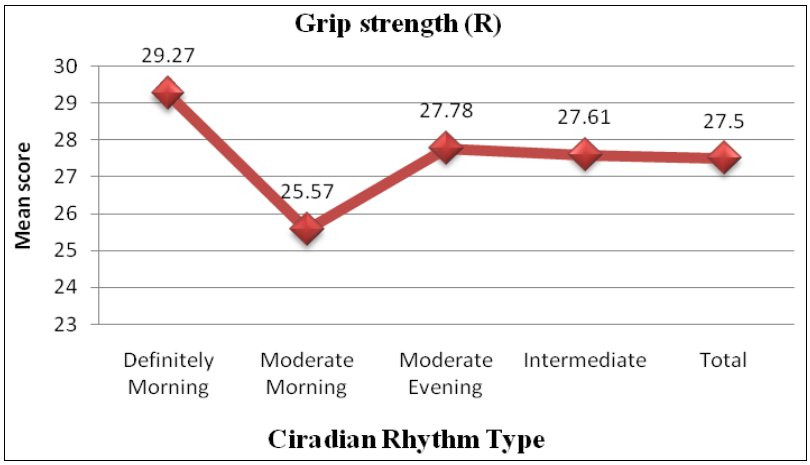

Fig 4: Marginal mean score of grip strength right hand in relationship with circadian

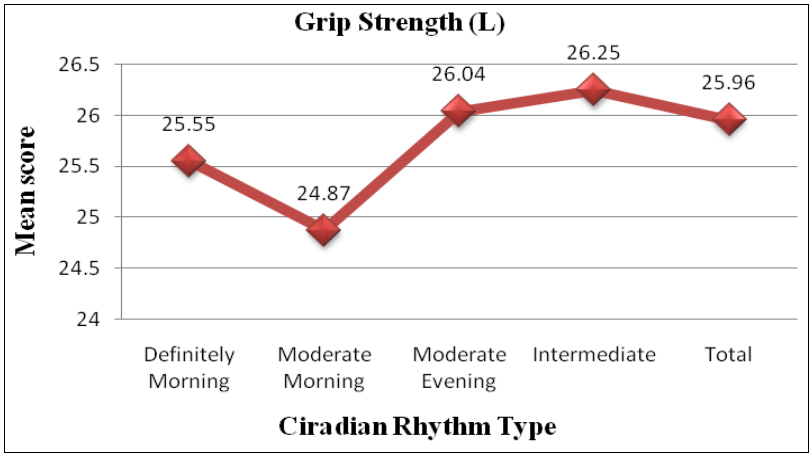

Fig 5: Marginal mean score of grip strength left in relationship with circadian rhythm

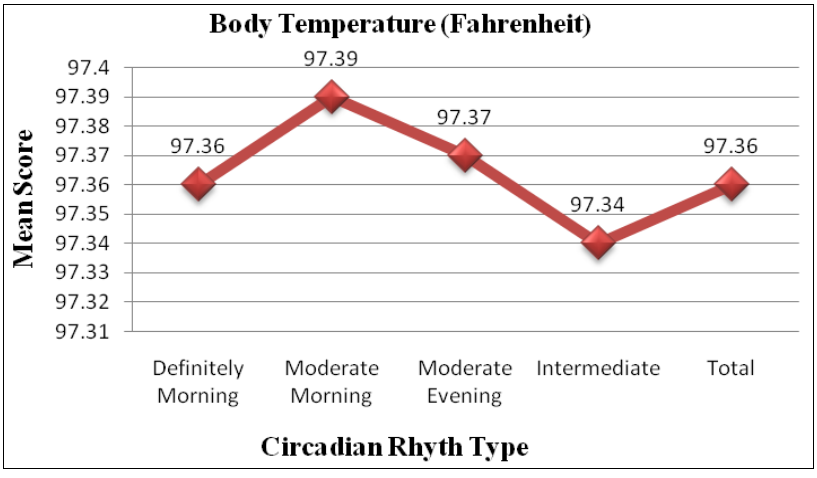

Fig 6: Marginal mean score of average grip strength right and left in relationship with circadian rhythm

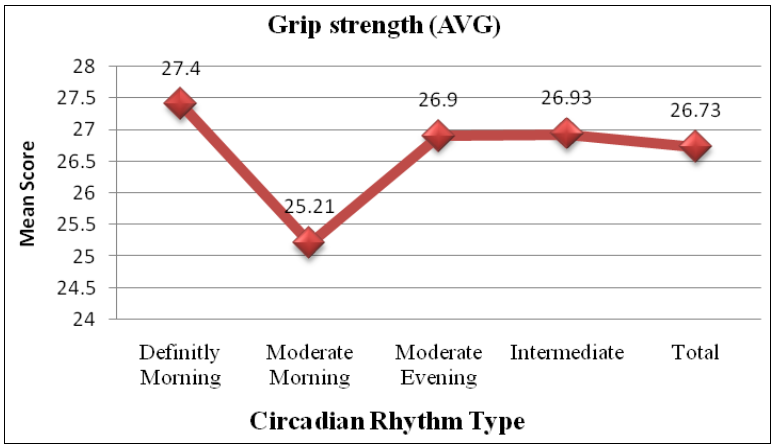

Fig 7: Marginal mean score body temperature in relationship with circadian rhythm

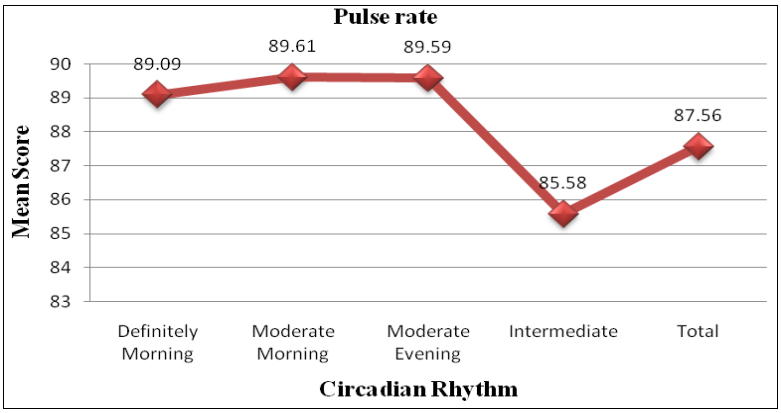

Fig 8: Marginal mean score of pulse rate in relationship with circadian rhythm

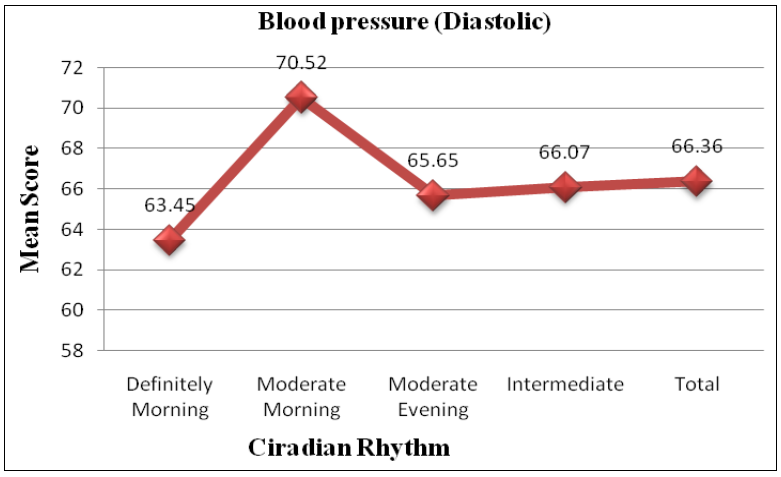

Fig 9: Marginal mean score of blood pressure (diastolic) in relationship with circadian rhythm

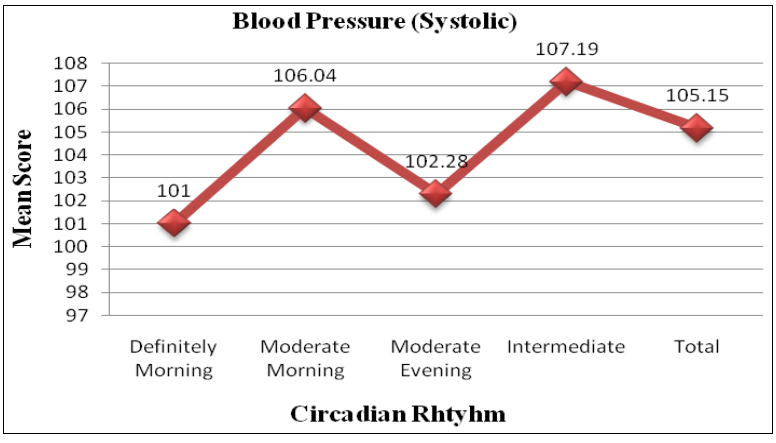

Fig 10: Marginal mean score of blood pressure (systolic) in relationship with circadian rhythm

Table 4: ANOVA on grip strength and average grip strength for the right and left handgrip strength, average grip strength of right and left hand in body temperature, pulse rate, blood pressure (diastolic) and blood pressure (systolic) with circadian rhythm

		Sum of squares	df	Mean square	F	Sig.
Grip (R)	Between Groups	125.969	3	41.990	2.765	.044
	Within Groups	2612.031	172	15.186		
	Total	2738.000	175			
Grip (L)	Between Groups	36.960	3	12.320	.697	.555
	Within Groups	3041.762	172	17.685		
	Total	3078.722	175			
Grip AVG	Between Groups	62.980	3	20.993	1.504	.215
	Within Groups	2400.450	172	13.956		
	Total	2463.430	175			
BT	Between Groups	.060	3	.020	.052	.984
	Within Groups	66.389	172	.386		
	Total	66.449	175			
Pulse Rate	Between Groups	690.564	3	230.188	1.159	.327
	Within Groups	34152.868	172	198.563		
	Total	34843.432	175			
BP (Diastolic)	Between Groups	526.077	3	175.359	.914	.435
	Within Groups	32994.372	172	191.828		
	Total	33520.449	175			
BP (Systolic)	Between Groups	1020.653	3	340.218	1.739	.161
	Within Groups	33657.506	172	195.683		
	Total	34678.159	175			

*> p 05 (2.25)

Analysis of variance was performed to find out any significant difference exists between dependent variables *viz.* grip strength (R), grip strength, grip strength (L) and grip strength (Avg.), Pulse rate, Blood pressure (Diastolic) and Blood Pressure (Systolic) with independent variable circadian rhythm namely: definitely morning type (DMT), moderate morning type (MMT), moderate evening type (MET) and intermediate type (IT). The table 4 shows that dependent variable grip strength (Right) found having significant differences between independent variables (F = 2.765, p>.044). Among the other dependent variables, no significant difference were found and the null hypothesis of no difference among the mean of four groups i.e., definitely morning type (DMT), moderate morning type (MMT), moderate evening type (MET) and intermediate type (IT) may be accepted at 5% level. The post hoc was performed only with dependent variable grip strength (R), since, no significant differences were found in other dependent variables grip strength (L), average grip, pulse rate, blood pressure (diastolic) and blood pressure (systolic).

Table 5: Pair wise comparisons on estimated marginal means of grip strength variable right

Dependent variable	(I) CR type	(J) CR type	Mean difference (I-J)	Std. Error	Sig.
Grip (R)	Definitely Morning	Moderate Morning	3.708*	1.429	.010
		Moderate Evening	1.495	1.289	.248
		Intermediate	1.659	1.246	.185
	Moderate Morning	Definitely Morning	-3.708*	1.429	.010
		Moderate Evening	-2.213*	.970	.024
		Intermediate	-2.048*	.913	.026
	Moderate Evening	Definitely Morning	-1.495	1.289	.248
		Moderate Morning	2.213*	.970	.024
		Intermediate	.164	.674	.808
	Intermediate	Definitely Morning	-1.659	1.246	.185
		Moderate Morning	2.048*	.913	.026
		Moderate Evening	-.164	.674	.808

*. The mean difference is significant at the 0.05 level.

The pair wise comparison presented on Table 5 clearly revealed that the grip strength (R) having significant difference with definitely morning type (DMT) and moderate morning type (MMT) (MD = 3.708) and no significant difference was found with other independent variables. Results also shows that, moderate morning type (MMT) also differ significantly with moderate evening type (MET) (MD = -2.213) and intermediate type (MD = -2.048). Intermediate type does not found differ with DMT and MET.

Conclusions

Circadian rhythms are present in several elements of sensory motor, psychomotor, perceptual, and cognitive function (Winget *et al*., 1985) [20]. Body temperature is a complex, non-linear variable that the subject to many sources of internal and external variation. Circadian rhythms are biological functions of approximately 24 hours length and are a significant source of body temperature variation. The daily pattern of body temperature is the most widely assessed circadian rhythm in chrono-biological studies. It is usually considered a “marker rhythm” and is used to determine time on an individual’s body clock and as a reference point to determine whether other rhythms are synchronized or desynchronized.

The study underlines the importance of being aware of the influence of the body temperature and circadian rhythm type

towards the selected physiological variables of the college women's baseball team. Strong observation analysis of the data which serves as an implication for the outcome of this investigation focus upon, the following conclusions were reached. The circadian rhythm had a significant influence on the subjects grip strength (R) but insignificant with physiological variables. The results to some extent agreed with the studies conducted by Reilly *et al*., (1997) [18] on the isometric strength of the knee extensors measured consecutively during the waking hours of the solar day, show a diurnal peaks at the end of the morning and another in the late afternoon/early evening. Similar study by Colquhoun, (1972) [6] shows that tasks, which demand fine motor control (e.g., hand steadiness and the ability to balance), are performed better in the morning, since arousal levels are lower than the diurnal peak and closer to the optimum level for performance. The similar finding by Conroy and O'Brien, (1974) on the complex aspects of performance such as mental arithmetic and short-term memory also peak in the early hours of the morning rather than in the evening.

Success in sports, as measured by competitive performance, is dependent upon a number of significant variables such as mental and physical components, stomata types, motor skills, age, national status, physiology, psychology, training level, genetic endowment and injury risk are the major variables influencing performance of sports persons. Women's performance in sports depends on her movement-oriented behavior and all these actions have their roots in biological phenomena. This biological phenomenon is the foremost and which fluctuate periodically is called biological rhythms. These biological rhythms have relatively a greater influence on sports performances. Since, sports take place at different times of the day, these studies provided the first indication that chronotype might be influenced by the time-of-day that the respective sports matches/ competitions or training sessions occurred. Understanding the influence of chronotype on performance, at different times of the day, could be a useful tool for coaches and athletes, with regards to improving training and racing principles".

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