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Original research article

To Assess the Influence of Moderate Intensity Exercises on P-300 Component of event Related Potentials among Young Obese and Non-obese Females of Bihar During Different Menstrual Phases.

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Abstract

Aim: The objective of the present study was to assess the effect of moderate intensity exercises on P-300 component of event related potential during different menstrual phases in young obese and non-obese women of Bihar.

Methods: It was a cross-sectional observational study conducted at Patna Medical College, Patna, Bihar, India, on young normally menstruating women with normal auditory capability of age group 18–35 years, BMI (Normal =18-24.9 kg/m^2 and Obese>25 kg/m^2) according to the WHO criteria and without any major chronic illness and neurocognitive deficit. The ethical approval for this study was obtained from Institutional Ethical Committee.

Results: It is evident from the study that the participants were mostly in the age group of 19–21 years. BMI of the normal subjects was mostly in between 19.4 and 22.13. BMI of the obese subjects was mostly in between 25.4 and 30.13. Waist–hip ratio (WHR) of the subjects was mostly little above normal range (normal being <0.8). Observation showed that most of the subjects perceived physical activity as light to extremely light except for a few subjects. The amplitude and latencies of P300 ERP in obese and non-obese showed no significant difference at resting state (pre-exercise) during early follicular and mid-luteal phases. The amplitude of P300 ERP displayed no significant change in post-exercise session in comparison to pre-exercise session in both phases among obese and non-obese subjects. However, P300 latency showed significant decrease in post-exercise session when recorded at Cz (P = 0.024, P = 0.05) as well as Pz position (P = 0.03, P = 0.003) in both phases of menstrual cycle among both groups. However, P300 latency recorded at Fz position displayed no significant change in post-exercise session in comparison to pre-exercise session in nonobese and obese persons during both phases of menstrual cycle.

Conclusion:- The inference from present study showed that moderate intensity exercises caused significant decline in latency of P300 ERP in the subjects (both non-obese and obese) during both follicular and luteal phases of menstrual cycle. Therefore, it indicates that even moderate intensity exercise significantly improves allocation of attentional resources and working memory in the subjects. Hence, it enhances cognitive functioning of the both non-obese and obese individuals but to a lesser extent among obese subjects.

Keywords:- P300 event-related potential(ERP), young women, obese & non-obese, moderate exercise, menstrual cycle, Cognitive function, Ovarian hormones.

Introduction

Female sex hormones have wide cyclic swings and the tissues affected by these hormones also undergo cyclical changes, the most important of which is the monthly menstrual cycle.[1] Majority of Indian women now-a-days are interested in sports participation[2]. Hence, it is necessary to know the variation in their performance in different phases of menstrual cycle. Since physical exercises or sports activities requires more oxygen and blood supply, the cardio-respiratory functions need to be normal and efficient.[3,4] Previous reports on variation in phases of menstrual cycle and reports on cardio-respiratory efficiency are inconclusive.[5] Maximum respiratory efficiency was documented in luteal phase and maximum cardiac efficiency was documented in post-menstrual phase.[6] In contrast, it was reported that menstrual cycle has no influence on cardio-respiratory efficiency.[7,8]

Prevalence of cardio vascular disorders is higher in younger adults with high amount of body fat which has adverse effects on cardiac efficiency and oxygen uptake by skeletal muscles.[9,10] Increasing facts suggest that ovarian hormones act as neurosteroids besides regulating reproductive functions and behavior. Cognitive function implies brain's ability to encode information, pattern recognition, attention and learning, memory and problem solving, language processing and abstract reasoning.[11] In emotional and cognitive processing, oestrogen and progesterone are also implicated.[12,13] Evidences show that a link between oestrogen depletion and risk for Alzheimer's disease (AD) is relatively consistent.[14] During luteal phase, high level of progesterone is responsible for enhanced emotional memory and altered ability for recognition of emotions accurately.[15]

Slower basic information processing may be linked with obesity but these processes are largely influenced by fitness. Earlier studies on obesity which examined other cognitive functions such as complex attention, visual and verbal memories showed that the processing speed is enhanced by fitness.[29]

Physical exercise is known to enhance a person's attentiveness and cognitive skills. Several studies documented that monoamine systems(dopamine, norepinephrine and serotonin), hormones [endocannabinoids and brain-derived neurotropic factor (BDNF)] act in a combined manner to increase exercise induced cognitive functions.[16]

Previous studies have shown the effect of moderate intensity exercises on executive capacity of brain in pre-adolescent children and older adults. In recent years, interest regarding effect of the physical activity on the brain and cognition has increased with mounting evidences indicating beneficial effect on several cognitive processes due to chronic participation and single session of moderate intensity exercise.[17]

Since both exercise and ovarian hormones seem to be having an effect on cognition, our present study aims to determine the effect of moderate intensity exercise in cognitive processing in young women in follicular phase, when the levels of oestrogen and progesterone are low as well as in midluteal phase, when the levels of both the hormones are high in both study groups.

The objective of the present study was to assess the effect of moderate intensity exercise on P-300 component of event related potential during different phases of menstrual cycle in young obese and non-obese women of North Bihar.

MATERIALS AND METHODS

It was a cross-sectional observational study conducted at Patna medical college, Patna, Bihar, India. Duration was of around one year. The study group consisted of 50 young women (non-obese and obese) with normal menstrual cycle and normal auditory capability, belonging to age group 18–35 years. Participants had no history of any major chronic illness or neurocognitive deficiency. The approval for this study was taken from Institutional Ethical Committee.

Methodology

The study was conducted in Department of Physiology, PMCH, Patna. Each participant had to attend two laboratory sessions, one in the early follicular phase (initial 3 days post-menstruation) and the other in mid-luteal phase(days 21–24). Phases were confirmed by taking menstrual history. Both sessions were attended preferably at the similar time of the day. Before commencement of the study, written informed consent was obtained from all the subjects. Individuals with cardio-respiratory diseases, dysmenorrhea, irregular menstrual cycles, polycystic ovarian diseases, infective diseases, arthritis were excluded. Categorization of normal weight, over weight and obese was performed according to World Health Organization (WHO) guidelines.[18]

Procedures

The participants were asked to avoid tea and coffee for at least 2 hours before attending laboratory sessions. They were directed to fill up Godin Leisure-Time Exercise Questionnaire (GLTEQ) to understand their leisure time exercise habits.[19] The data collection proforma was used to record information relating to their anthropometric measurements namely height, weight, body mass index (BMI), waist–hip ratio and their detailed menstrual history. Following this, all relevant physiological parameters were recorded. Mercuric sphygmomanometer was used to measure systolic blood pressure (SBP) and diastolic blood pressure (DBP) at rest using standard protocol. Mean arterial pressure (MAP) and pulse pressure (PP) values were calculated from the obtained datas. Central BP and HR were recorded by supra-systolic oscillometric technology. Following this, basal P300 was recorded. EEG electrodes were placed at different positions on scalp in a fashioned manner. Afterwards, the subjects were asked to perform Harvard's step test till 60–80% of their maximum heart rate (maximum heart rate = 220 – age) is achieved during exercise.[20] Pulse oximeter was used to monitor the heart rate of the subjects after exercise and when their heart rate returned to basal value, P300 ERP was again recorded. The participants were asked to fill up Borg perceived exertion scale questionnaire at the end of exercise.

Statistical analysis

The distribution pattern of data was tested by Shapiro–Wilk test of normality and it was found that data were not normally distributed. Therefore, the data are presented as median (interquartile range). Wilcoxon signed-rank test was employed for comparison of variables in pre and post exercise session during early follicular and mid-luteal phase. Wilcoxon signed-rank test was also employed to compare P300 ERP amplitude and latencies at resting state (pre-exercise) during early follicular and mid-luteal phase. MANCOVA has been employed to examine the effect of basal activity level on P300 ERP amplitude and latencies, while age, height, weight, BMI and WHR were considered as covariates in both phases. All statistical calculations have been done using computer programs (Microsoft Excel 2013) and statistical analysis has been done by SPSS 20 version. A two-tailed P < 0.05 has been taken as the cut-off level of significance.

RESULTS

Table 1: Demographic characteristics of the participants.

Age(year) [median(IQR difference)]	Height(cm) [median(IQR difference)]	Weight(kg) [median(IQR difference)]	BMI(kg/m2) [median(IQR difference)]	Waist–hip ratio (WHR) [median(IQR difference)]
22.0 (2.3)	159.0 (12)	73.0 (10)	28.85 (2.9)	0.9 (0.1)

Table -1 shows that the participants belonged mostly to the age group of 19–25 years and BMI of the normal subjects was mostly in between 19.4 and 22.13. BMI of the obese subjects was mostly in between 25.4 and 30.13. Therefore, as per the WHO Asian criteria, BMI of the participants was mostly normal while Waist–hip ratio (WHR) of the subjects was little above the normal range (normal being <0.8).

Table 2: Difference between various physiological variables recorded in pre and post exercise session of the study subjects; during early follicular and mid-luteal phase of menstrual cycle.

Original Borg scale Rating (physical activity)	Early follicular phase	Mid-luteal phase
Extremely light	05	05
Very light	13	12
Light	15	17
Somewhat hard	17	16

Table -2 shows that most of the subject felt physical activity as light to extremely light. At the end of step test Borg perceived exertion scale questionnaire was administered, which was analyzed by the original Borg scale or category scale (6–20 scale).

Table 3: Exercise efficiency of non-obese and obese subjects in various phases of menstrual cycle.

	Phase	Mean	Std. Deviation	Friedman's test	p-value
Non-obese	Early follicular	78.67	9.808	18.112	<0.001
	Mid luteal	82.03	10.829		
obese	Early follicular	70.23	8.7557	17.869	<0.001
	Mid luteal	73.76	9.737		

Table -3 shows that the exercise efficiency of the nonobese and obese subjects were significantly different during the various phases of the menstrual cycle.

Table 4:-Comparison of different physiological parameters[using Wilcoxon signed-rank test] during early follicular and mid-luteal phase of the study subjects(obese and non-obese) recorded in pre and post-exercise session.

TABLE- 4[A]

Parameters	**Phases**					
Non-obese	**Follicular**			**Luteal**		
	Pre-exercise	**Post-exercise**	**P value**	**Pre-exercise**	**Post-exercise**	**P value**
Central systolic blood pressure (mmHg)	98.0 (15)	112.0 (10)	0.0001	98.0 (15)	110.0 (13)	0.001
Central diastolic blood pressure (mmHg)	68.0 (13)	75.0 (11)	0.005	66.0 (18)	72.0 (10)	0.100
Peripheral SBP (mmHg)	107.0 (13)	121.0 (15)	0.0001	107.0 (14)	122.0 (19)	0.002
Peripheral DBP (mmHg)	66.0 (7)	71.0 (9)	0.001	65.0 (17)	70.0 (11)	0.028
Heart rate (bpm)	83.0 (15)	103.0 (15)	0.0001	85.0 (17)	97.0 (16)	0.0001
P300 amplitude (µv)	18.9 (10.3)	17.3(10.1)	0.811	18.9 (7.8)	18.0 (8.5)	0.126
P300 latency at Fz (ms)	307.0 (30)	305.0 (49)	0.205	309.0 (33)	309.0 (60)	0.295
P300 latency at Cz (ms)	307.0 (26)	296.0 (32)	0.024	307.0 (31)	294.0 (43)	0.050
P300 latency at Pz (ms)	307.0 (23)	297.0 (31)	0.033	307.0 (27)	294.0 (37)	0.003

Data shown in table-4A are as Median (Interquartile range) & Fz, Cz, Pz are active electrodes placed on scalp at medial frontal position, medial central position & medial parietal position respectively.

TABLE- 4[B]

Parameters	**Phases**	
Obese	**Follicular**	**Luteal**

	Pre-exercise	Post-exercise	P value	Pre-exercise	Post-exercise	P value
Central systolic blood pressure (mmHg)	96.0 (15)	111.0 (10)	0.0001	98.0 (15)	109.0 (13)	0.001
Central diastolic blood pressure (mmHg)	65.0 (13)	73.0 (11)	0.005	63.0 (18)	70.0 (10)	0.100
Peripheral SBP (mmHg)	110.0 (13)	124.0 (15)	0.0001	109.0 (14)	128.0 (19)	0.002
Peripheral DBP (mmHg)	69.0 (7)	74.0 (9)	0.001	67.0 (17)	72.0 (11)	0.028
Heart rate (bpm)	88.0 (15)	109.0 (15)	0.0001	90.0 (17)	103.0 (16)	0.0001
P300 amplitude (µv)	18.8 (10.3)	17.2(10.1)	0.811	18.9 (7.8)	18.1 (8.5)	0.124
P300 latency at Fz (ms)	306.0 (30)	303.0 (49)	0.204	308.0 (33)	307.0 (60)	0.294
P300 latency at Cz (ms)	308.0 (26)	297.0 (32)	0.023	306.0 (31)	295.0 (43)	0.051
P300 latency at Pz (ms)	306.0 (23)	295.0 (31)	0.032	308.0 (27)	293.0 (37)	0.004
Data shown in table-4B are as Median(Interquartile range) & Fz, Cz, Pz are active electrodes placed on scalp at medial frontal position, medial central position & medial parietal position respectively.						

Table -4 [A & B] shows that all mentioned cardiovascular parameters vary significantly in post-exercise session as compared to pre-exercise session in non-obese and obese subjects in follicular as well as luteal phases of menstrual cycle. At resting state (pre-exercise) there were no significant differences in P300 ERP amplitude and latencies during early follicular and mid-luteal phases in both obese and non-obese females. Also in comparison to pre-exercise session in both phases, the post-exercise session showed no significant variation in the amplitude of P300 ERP. But P300 latency recordings at Cz and Pz positions revealed significant decrease in post-exercise session in both menstrual phases. However, at Fz position P300 latency recording showed insignificant variation during post-exercise session as compared to pre-exercise session during both menstrual phases in both category of subjects.

DISCUSSION

Menstrual cycle is one of the most important biological rhythms, generated by the interplay between hypothalamus, hypophysis, and ovarian hormones. It is divided into follicular, ovulatory and luteal phases on the basis of ovarian functions.[21] These phases are influenced by varying levels of oestrogen and progesterone during the cycle. During follicular and luteal phase there is increase in both the oestrogen and progesterone level while in the ovulatory phase there is an increase in the oestrogen level but the progesterone level decreases.[22]
Oestrogen and progesterone have multiple actions on various body systems besides reproductive functions.[23] Exercise capacity and performance is remarkably influenced through mechanisms such as substrate metabolism, cardio respiratory function, thermoregulation and psychological factors.

There is no consistent finding in the literature regarding changes in latency and amplitude of P300 ERP during menstrual cycle. Early studies had shown that P300 ERP elicited in obese and non- obese women on the 1st day of menstrual cycle and approx. 14 days later revealed no change in amplitude or latency. Therefore, the study concluded that menstrual cycle does not affect P300 and other ERP components.[24] Later on, a cross-sectional study was conducted to examine the changes in P300 component of visual ERPs and in BAEPs across the menstrual cycle in healthy women. It was documented that latency of P300 was longer during ovulatory phase.[25]

Another study reported that amplitude of P300 ERP was significantly greater during menstrual phase than ovulatory phase. The study concluded that context updating mechanisms as indexed by P300 ERP are sensitive to cyclic hormonal fluctuations.[26] It is understandable that there is no boundation regarding changes in amplitude and latency of P300 ERP in different phases of menstrual cycle.

The present study did not find any significant difference in amplitude and latency of P300 ERP recorded at resting state (pre-exercise) during early follicular and midluteal phase in both non-obese and obese subjects. The findings of various studies conducted on effects of menstrual cycle on cognitive functions have been fairly inconsistent. This could be explained based on the fact that oestrogen and progesterone have known to exert opposite effects on a variety of neurotransmitters in the brain.

Many research studies documented the beneficiary effect of acute bout of exercise on improving cognitive function of brain which involves response inhibition, cognitive flexibility, selective attention and working memory. It was reported earlier that there were differential influences of mild, moderate and high-intensity pedaling exercise on P300 ERP. The authors observed that amount of attentional resources to a given task was decreased with high-intensity pedaling exercise, but it was increased with moderate intensity pedaling exercise. However, there was no change after low-intensity pedaling exercise. Hence, it was inferred that differences in exercise intensity influenced information processing in the CNS.[27]

Another study conducted in India documented that latency of P300 was significantly decreased in sedentary individuals following acute moderate exercise.[19] It was further reported that acute bout of physical exercise causes reduction in P300 ERP latency and reaction times in both athlete and non-athlete groups.[28]

In the present study, P300 latency has been reduced during postexercise session which reflects enhanced attention allocation and faster information processing. However, the amplitude of P300 ERP displayed no significant change in post-exercise session in comparison to pre-exercise session in both phases in both groups. Interestingly, inferential statistical analysis revealed that only amplitude of P300 ERP (P = 0.024) in post-exercise session during mid-luteal phase was affected by activity level of the participants significantly. However, amplitude and latencies of P300 ERP in other experimental conditions were not affected by activity level. Taken together, it seems that the findings of the present study are more or less in concordance with the previous studies. Therefore, it can be inferred that exercise enhances release of monoamine system and several neurohormones, namely endorphins and BDNF, which act in a concerted fashion to bring about significant change in selective attention, response engagement, working memory and cognitive flexibility which are of paramount importance in dealing day-to-day situation in life.

CONCLUSION

The inference from present study showed that moderate intensity exercise caused significant decline in latency of P300 ERP in the subjects (both non-obese and obese) during both follicular and luteal phases of menstrual cycle. Therefore, it indicates that even moderate intensity exercise significantly improves allocation of attentional resources and working memory in the subjects. Hence, it enhances cognitive functioning of the both non-obese and obese individuals but to a lesser extent among obese subjects.

Conflicts of interest

There are no conflicts of interest.

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