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IMPACT OF PERCEIVED STRESS ON COGNITIVE ABILITY AND PHYSICAL PERFORMANCE IN YOUNG ADULTS

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ABSTRACT

The stress, an inevitable part of modern era, creates lot of adverse effects on younger generation as they are exposed to a lot of novel challenges in daily life. The best way to combat the consequences of stress is to develop physical and cognitive strength. This message should reach the younger generation. In the present study, we made an attempt to bring out the impact of perceived stress on some physiological functions and correlate the stress, cognition and physical performance in young adults. 30 undergraduate male students of Madha Medical College and Research Institute in Chennai (18-20 years) participated in the study. Perceived Stress was measured using perceived stress scale (PSS), cognition was measured by Montreal cognitive assessment (MoCA) scale and physical performance was measured in terms of rate pressure product (RPP) which was the product of heart rate (HR) and systolic blood pressure (SBP). Mean PSS score, MoCA score and RPP was 17.8 ± 4.52, 26.2 ± 2.44 and 16458 ± 3174.00 (mean ± SD) respectively. Correlation studies showed that there was positive correlation between PSS and RPP (r=0.22) and negative correlation between PSS and MoCA (r= -0.19) and MoCA and RPP (r= -0.28). These three domains can be used in assessing the overall ability of an individual to face the

stress and perform accordingly. If there is deviation in any of these domains, then it should be considered as an alarming sign and appropriate intervention should be done to avoid further complications.

KEYWORDS: Stress, Perceive stress scale, Montreal cognitive assessment scale, Physical performance, Rate pressure product.

INTRODUCTION

Stress is an integral and inevitable aspect of life. It throws challenges in the form of threat to the mental and physical wellbeing of a living organism. Fortunately, every organism is armored against these challenges in the form of inherent ability to withstand the threats through many physiological systems like nervous system, endocrine system etc. The factors that are responsible for these challenges are collectively called as stressors and the integrated responses that arise in the organism to fight against these stressors are called stress responses. Depending upon the nature, intensity and the response of the organism to the stressor, the stress is classified as eustress and distress.[1, 2, 3]

There are several forms of stressors like emotional stressors, physical stressors, chemical stressors etc. Whatever may be the type of the stressor, its impact on the body depends upon the duration (acute or chronic), intensity and the way it is received (perceived stress). Within physiological limits, all these stressors remain as eustress and are well tolerated by the body through many positive biological responses and homeostasis.[3] If the duration and the intensity of the stress increase, then eustress may turn into distress with its own consequences.

Perceived stress is an emotional stress showing how it is faced by the individual and how it affects him/her mentally. It is more concerned with the mental perception of the stress by the individual involving the thought about the consequences of the stress and the action to be taken against it. This type of stress is assessed by using perceived stress scale (PSS).[4] PSS-10 version is known to have good reliability and validity.[5]

Cognition is the "psychological process" involved in acquisition and understanding of knowledge, formation of benefits and attitudes and decision-making and problem solving. They are distinct from emotional and volitional process involved in wanting and intending. Cognitive capacity is measured generally with intelligent quotient (IQ) tests". [6, 7] Montreal

cognitive assessment (MoCA) is the commonly used test to assess the cognition of an individual. It is a widely accepted and valid questionnaire.[8]

Physical performance is the strength and capacity of the individual to do his daily routine work and/or professional activities. It determines the physical fitness of the person. A person is said to be fit if he can perform his daily routine activities without any difficulty. Performance for the professional activities like sports depends on the prescribed standards of fitness. General fitness is achieved through regular exercise and maintenance of a balanced diet.[9] Physical performance and general fitness is assessed under stressed conditions like exercise. Cardiovascular variables viz., heart rate (HR) and blood pressure (BP) are most reliable indicators of the general fitness of a person.

Now-a-days, rate-pressure product (RPP) is becoming popular to assess the general as well as cardiovascular fitness. RPP is the product of HR and systolic blood pressure (SBP) [RPP = Systolic blood pressure (SBP) × heart rate (HR)/1,000].[10, 11] It is one of the reliable, reproducible, simple and cost-effective variables in determining the physical fitness.[12, 13, 14] RPP indicates the oxygen (O_2) consumption by the myocardium and also the status of ventricular function. Cardiac O_2 consumption is to be considered as an important factor before starting the athletic training or in deciding the extent of exercise in people with obesity, cardio-respiratory problems, diabetic mellitus etc. It is also useful for normal health-conscious persons.

Whoever it may be, exercise should be done within limits. Otherwise, it will have an adverse effect on the body. In fact, if the cardiac muscle is over-worked beyond limit, it may lead to the development of angina. This "limit" can be determined by knowing RPP. [15] Under resting conditions, safer RPP should range between 7000 and 9000 and if it goes beyond 10,000, it becomes a risk factor for heart disease. If it crosses 22000, then it becomes a prelude of myocardial ischemia and angina.[16, 17]

Taking all these into consideration, it makes us to understand that perceived stress has got an impact on cognitive appraisal and is capable of influencing physical performance and cognition of an individual. So, in the present study an attempt had been made to explore the inter-relation of the stress, cognition and physical performance of the young adults.

MATERIALS AND METHODS

The study was conducted in Madha Medical College and Research Institute during the period of December 2012 and May 2013. The participants were the normal healthy undergraduate medical students in the age group of 18 to 20 years. All were male students; females were not included due to the interference and consequences of the monthly menstrual cycle. Subjects with any medical problem like psychiatric illness, neurological problems, metabolic disorders, cardiovascular problems etc., and those who were on medication for some reason or other were excluded from the study. Approval was obtained from Institutional ethical committee. Written informed consent was taken from all the participants after explaining the procedure and their role in the project, giving a clear understanding that they could withdraw from the study at any time.

Subjects were instructed to report in the Clinical laboratory of Physiology Department between 9 and 11 AM. Anthropometric measurements like age, height and weight were noted in the subjects. Body mass index (BMI), body fat percentage (BF %) and basal metabolic rate (BMR) were measured by using the Body Fat Monitor (OMRON). Perceived stress was assessed by using PSS. Cognition was assessed by MoCA scale. Physical performance was assessed by making the subjects to do cycling on a bicycle ergometer against the load of 2 kg with pedaling speed of 16 revolutions per minute (RPM) for 5 minutes.

Assessment of Perceived stress

Perceived stress was assessed by using PSS-10 version. It consists of 10 questions, each having 5 responses. Time given to perform this test was 5 min. Each response was given a score 0, 1, 2, 3, 4. Total Perceived Stress was determined by the sum items: 1, 2, 3, 4R, 5R, 6. 7R, 8R, 9, 10. Maximum score was 40. The normal average score is 13 or less than13. The score 20 or above is considered as stress.[18, 19]

Montreal cognitive assessment (MoCA)

Cognition was assessed by using MoCA test. It is a one-page 30-point test. It assesses several cognitive domains like attention, concentration, executive functions, memory, language, visuo-constructional skills, conceptual thinking, calculations, and orientation. Time to administer the MoCA was 10 minutes. [13] The short-term memory recall task (5 points) involved two learning trials of five nouns and delayed recall after approximately 5 minutes. Visuospatial abilities were assessed using a clock-drawing task (3 points) and a three-dimensional cube copy (1 point). Multiple aspects of executive functions were assessed using

an alternation task adapted from the trail-making B task (1 point), a phonemic fluency task (1 point) and a two-item verbal abstraction task (2 points). Attention, concentration and working memory were evaluated using a sustained attention task (target detection using tapping; 1 point), a serial subtraction task (3 points), and digits forward and backward (1 point each). Language was assessed using a three-item confrontation naming task with low-familiarity animals (lion, camel, rhinoceros; 3 points), repetition of two syntactically complex sentences (2 points) and the aforementioned fluency task. Finally, orientation to time and place was evaluated (6 points). The total possible score was 30 points; a score of 26 or above was considered normal. [20, 21, 22]

Physical performance test

Physical performance was assessed by making the participants to do cycling.[15] Basal systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were noted first and then subjects were instructed to do cycling on a bicycle ergometer with fixed load, speed of paddling and time. Fixed load of 2 kg was maintained throughout the experiment. Speed of paddling was maintained between 12-16 times per min. Exercise was done for a period of 5 min. SBP, DBP and HR were measured again - immediately after the exercise and 10 minutes after exercise (recovery)

Rate pressure product was calculated by multiplying HR and SBP. Hemodynamic response or cardiac workload is said to be high if the RPP is more than 22000 and low if RPP is less than 7000.[15, 17]

Statistical analysis was done in SPSS version 21. Significance between the events were evaluated by using Student's t test.

RESULTS

The values in the text of results, tables and figures were expressed either as mean ± SEM or mean difference ± SEM. In Table 1 and 2, values were in mean ± SEM and in Table 3; values were in mean difference ± SEM.

General features

The mean age of the participants was 18.6 ± 0.83 years. The mean height and weight was 169.3 ± 8.62 cm and 61.3 ± 13.26 kg respectively. The mean BMI was 21.6 kg/m^2 and mean BMR was 1515.1 ± 263.25 kcal. (Table 1)

PSS and MoCA

The mean PSS and MoCA scores were 17.8 ± 4.52 and 26.2 ± 2.44 respectively (Table 1).

Impact of perceived stress on exercise-induced changes in cardiovascular parameters

HR was 84.67 ± 2.69 at basal conditions. It increased to 119.03 ± 4.07 at the end of exercise. After 10 minutes' rest (recovery), it was reduced to 92.87 ± 3.41 (Table 2).

Table 1: Description of General parameters

Parameters	mean ± SD
Number	30
Age	18.6 ± 0.83 years
Height	169.3 ± 8.62 cm
Weight	61.3 ± 13.26 kg
Body Mass Index	21.6 ±4.15 kg/m^2
Basal Metabolic Rate	1515.1 ± 263.25 kcal
Body Fat	21.2 ± 7.85 %
Perceived Stress Scale	17.8 ± 4.52
Montreal cognitive assessment Scale	26.2 ± 2.44

SBP at the basal condition, at the end of exercise and recovery was 122.77 ± 2.45, 139.07 ± 3.16, and 126.47 ± 2.72 mm Hg respectively (Table 2). There was significant increase in SBP immediately after exercise and came back to its near basal value after 5 min of rest (Table 2). DBP did not show any significant change between basal condition, end of exercise and recovery period (74.17 ± 2.18; 74.43 ± 3.40; 72.90 ± 2.61 respectively) (Table2).

RPP was 10422.00 ± 415.65 at the basal condition. It was increased to 16458.30 ± 579.62 at the end of exercise and reduced to 11761.20 ± 532.80 after 10 minutes' recovery (Table 2).

Table 2. Physical exercise-induced changes in cardiovascular parameters after PSS

Variable	Time of recording (mean ± SEM)		
	Basal	End of exercise	Recovery
HR (beats/min)	84.67 ± 2.69	119.03 ± 4.07	92.87 ± 3.41
SBP (mmHg)	122.77 ± 2.45	139.07 ± 3.16	126.47 ± 2.72
DBP (mmHg)	74.17 ± 2.18	74.43 ± 3.40	72.90 ± 2.61
RPP	10422.00 ± 415.65	16458.30 ± 579.62	11761.20 ± 532.80

HR – heart rate, SBP- systolic blood pressure, DBP – diastolic blood pressure, RPP – rate pressure product

Difference in the impact of perceived stress on exercise-induced changes in cardiovascular parameters

Heart rate

After perceived stress, physical exercise in the form of cycling was done: there was highly significant increase in HR immediately after exercise (the mean difference was - 34. 37 ± 3.31with $p < 0.000$). When compared with basal HR, it remained elevated significantly (-8.20 ± 1.73 with $p < 0.000$). Between excise-induced and recovery changes, HR was significantly high at the end of exercise (26.17 ± 3.26 with $p < 0.000$) than at recovery (Table3).

Systolic blood pressure

After perceived stress, SBP was significantly more at the end of exercise than at the basal level (mean difference was -16. 30 ± 3.69 with $p < 0.000$). Between the basal and recovery conditions, SBP remained elevated non-significantly (difference was – 3.70 ± 3.74 with $p < 0.330$). Compared to the recovery change, SBP was significantly more at the end of exercise (difference was 12.60 ± 3.49 with $p < 0.001$) (Table 3)

Diastolic blood pressure

DBP did not show any significant change after exercise or after recovery compared to that of basal condition (mean difference was – 0.27 ± 3.02 with $p < 0.930$; 1.27 ± 2.93 with $p < 0.672$ and 1.53 ± 2.98 with $p < 0.610$) (Table 3).

Rate pressure product

RPP increased significantly from basal value after exercise (mean difference was –6036.30 ± 598.87 with $p < 0.000$). After recovery, RPP remained significantly elevated than the basal condition (difference was –1339.20 ± 406.45 with $p < 0.003$). Between exercise and recovery conditions, RPP were significantly more at the end of exercise than at end of recovery stage (difference was 4697.10 ± 599.43 with $p < 0.000$) (Table 3).

The Pearson's correlation test

The Pearson correlation test was applied between the PSS, MoCA and RPP. There was positive correlation between PSS and RPP ($r=0.22$) whereas there was negative correlation between PSS and MoCA ($r= -0.19$) as well as MoCA and RPP ($r= -0.28$) Fig 1, 2 and 3)

Table 3. Difference in cardiovascular changes between basal condition, exercise-induced and recovery period

Variable	Difference between	mean difference ± SEM	Significance p <
HR (beats/min)	Basal & exercise	- 34.37 ± 3.31	0.000*
	Basal & recovery	- 8.20 ± 1.73	0.000*
	Exercise & recovery	26.17 ± 3.26	0.000*
SBP (mmHg)	Basal & exercise	- 16.30 ± 3.69	0.000*
	Basal & recovery	- 3.70 ± 0.3.74	0.330
	Exercise & recovery	12.60 ± 3.49	0.001*
DBP (mmHg)	Basal & exercise	- 1.27 ± 2.96	0.930
	Basal & recovery	1.27 ± 2.96	0.672
	Exercise & recovery	1.53 ± 2.98	0.610
RPP	Basal & exercise	- 6036.30 ± 59.87	0.000*
	Basal & recovery	- 1339.20 ± 406.45	0.003*
	Exercise & recovery	4697.10 ± 599.43	0.000*

HR – heart rate, SBP- systolic blood pressure, DBP – diastolic blood pressure, RPP – rate pressure produc

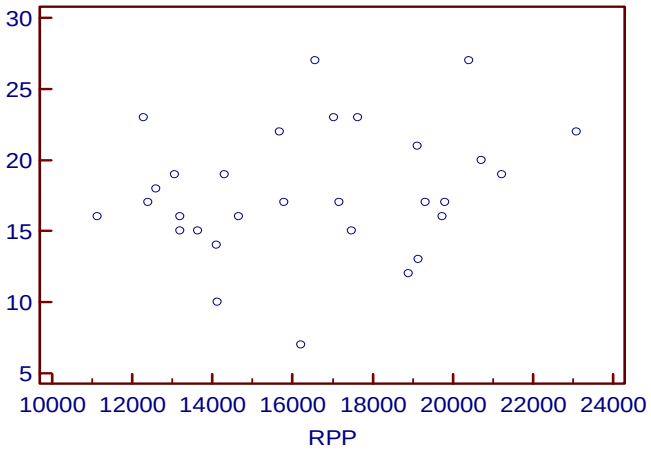

Fig 1: Scatter diagram for PSS and RPP

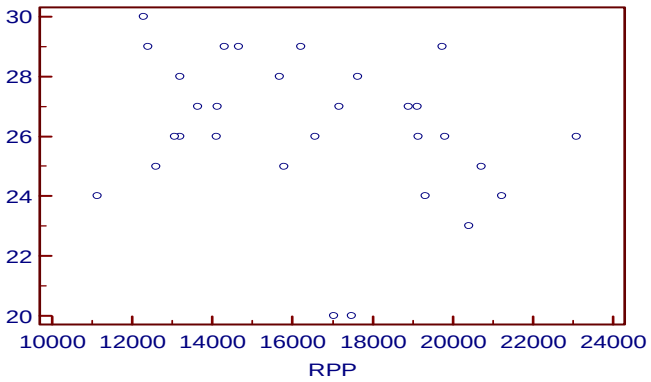

Fig 2: Scatter Diagram for RPP and MoCA

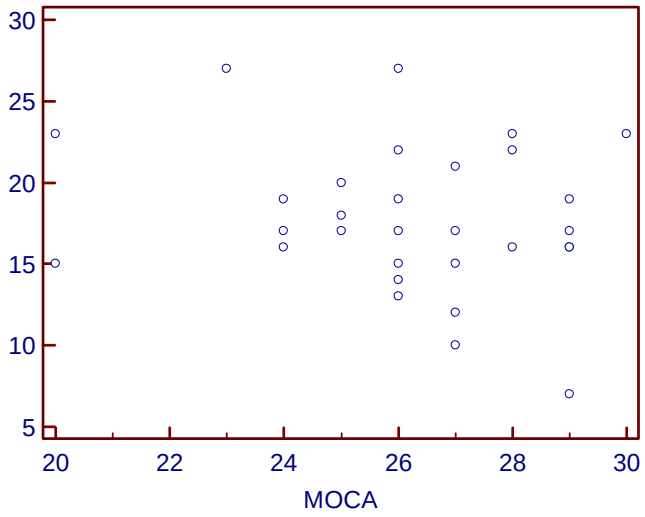

Fig 3: Scatter Diagram for PSS and MOCA

DISCUSSION

The results of the present study throws light on the ability of the younger generation in facing the stress and its consequences on their cognition of the perceived stress and its impact on the physical performance. The cognition of the stress seems to be normal in the participants as per MoCA score (26.2 ± 2.44). According to normative data put forth by Ratchford TL et al (2008), the score of more than 26 is considered to be normal, and score of less than 22 was considered to be having mild cognitive impairment.[21, 15] All the participants in this study had normal cognitive scores.

The perceived stress scale scores of the participants in this study were mildly increased than the normal range (17.8 ± 4.52). According to González et al (2013), the normative scores for PSS-10 for young adults were 14.52 to 17.73. [19] Young adults are prone to feel the stress in an exaggerated way. This may be the reason for RPP to remain elevated significantly after recovery period also (Tables 2 and 3). This may be because they are in the process of growing mentally and physically, acquiring new concepts and new skills in different environments. But at the same time, they should know how to be adaptive and receptive in accepting these new changes. They should develop or maid to develop the physical and psychological adaptations to cope with the changes. [1, 17] Otherwise, what starts as a eustress may end with distress with all its consequences.

Physical performance of subjects was assessed using the RPP which correlates with the myocardial oxygen consumption. It is one of the good indices to test the cardio-respiratory

status in various physiological and pathological conditions. All the participants had a favorable RPP. This suggests that all the individuals had good hemodynamic adjustments to the exercise task which was suggested to them. A similar study was done by Singh et al (2013) amongst anemic subjects; it was found that the RPP was unfavorably increased in the anemic participants compared to that of normal participants.[23]

In our study also RPP at the end of recovery stage was slightly unfavorable; it remained elevated even after rest. Though the values were within normal limits, yet we have to give a concerned thought about it.

It may be because the impact of the stress by cognition and physical performance (though the scores were normal) was stronger than expected. Literature reveals that stress in any form – mental (cognition) or physical (exercise) – increases BP and HR through the stimulation of different parts of the nervous system. Mental stress increases HR and SBP by stimulating limbic system (prefrontal cortex, the hippocampus, and amygdala).[24, 25, 3] Physical exercise increases HR and SBP by increasing sympathetic activity and reducing parasympathetic activity. [26, 27, 28, 15] In normal persons, the stress effect should vanish after withdrawal of the stress. But in the present study, the subjects being normal, the RPP (HR and SBP) remained elevated significantly. It is worthwhile to probe into the matter and do the needful to avoid any future complications.

The Pearson's correlation test was applied between the PSS, MoCA and RPP. There was positive correlation between PSS and RPP (r=0.22) whereas there is negative correlation between PSS and MoCA (r= -0.19) as well as MoCA and RPP (r= -0.28). The positive correlation of PSS and RPP suggests that the stress and hemodynamic performance of the individual may be related. As the person starts perceiving anything as stress, the performance becomes more unfavorable. Similarly the negative correlation between PSS and MoCA suggests that higher the perceived stress lesser the cognitive performance. It is same with MoCA and RPP also - more the cognitive score, lesser the RPP.

Thus, there is definite relationship between the three parameters and there should be balance between all the three to thrive successfully. The cognitive enhancement is possible through stress management and increasing the physical performance. Perceived stress is the factor which actually needs a special attention in the young adults as it is difficult to make them realize the adverse effects of distress on themselves.

The correlation of all the three variables and the intervening of them on one another are good revelations and if the people are made to understand the different coping strategy, lot of physical and mental complications can be avoided. It is best to start it in younger age where the cognition and perception of the situations are quick and sharp.

CONCLUSION

PSS, MoCA and physical performance are the three domains that can be used as parameters in assessing the individuals for their overall ability to learn things and perform better. If there is deviation in any of these domains, then it should be considered as an alarming sign and appropriate intervention should be done to avoid the future complications.

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