Original Article

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Cardiovascular Reactivity to Stressors in Indian Young Adults with Normotensive Parents

Physiology Section

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ABSTRACT

Backgrounds and Objectives: Stress-induced increase in heart-rate and blood pressure is termed cardiovascular reactivity (CVR). Various studies are designed to monitor the CVR and use different types of experimental stressors. We have compared the CVR to three different stressors used in CVR based studies (cold pressor task, hand grip test, and video game) to identify the best suited stressor for any study design.

Material and Methods: The study was conducted on 82 (38 female) young Indian adults with normal resting basal parameters and normotensive parents. Each volunteer was subjected to three stressors: cold pressor task (CPT), hand grip test (HGT), and video game (VG). The CVR to the three stressors was compared amongst female subjects and amongst male subjects by ANOVA, and between female and male subjects by unpaired Student's t-test.

Results: Maximum CVR was obtained to HGT, while maximum gender difference in CVR was obtained in case of CPT. Heart rate and blood pressure changes obtained on playing VG were not statistically significant.

Conclusion: When the purpose of research is to generate maximum possible CVR, we suggest the use of HGT; while if the purpose of the research is to study gender related differences, the use of CPT would be more appropriate. Unlike young adults of Western countries, VG is not perceived as a challenging task or stressor by young Indian adults and produces little change in heart rate and blood pressure.

Key words: Cardiovascular reactivity, Cold pressor task, Hand grip test, Stressor, Video game

INTRODUCTION

Stress is the response developed in an individual on adverse interaction with the environment. It has both physical and psychological components that produce autonomic arousal.The cause of stress may be physical (fasting, exercise, exposure to heat or cold, pain, etc.) or mental (emotional, apprehension or performance related, etc.). Pain-induced stress has both physical and psychological components. Stress affects the hypothalamus via the limbic system, causes activation of the sympathetic nervous system and the hypothalamic-pituitary-adrenocortical axis [1]. The response produced in an individual on exposure to stress is modulated by the psychological susceptibility of the individual, which in turn, is influenced by the individual's personality and environment. Exposure to stress produces an increase in heart rate and blood pressure, termed as cardiovascular reactivity (CVR). Exaggerated CVR to stress has been shown to be an indicator of future hypertension [2,3]. Gender differences in blood pressure responses to acute stress have been studied previously [4]. Stress induced by pain has been shown to vary with genetic [5], racial [6], cultural [7], and socioeconomic [8] factors.

In this study, CVR to three different stressors (cold pressor task, hand grip test, and video game) has been compared in young adults (with normotensive parents) of both sexes, to determine the suitability of the stressors for studies designed on CVR.

MATERIAL AND METHODS

This experimental study was conducted at Teerthanker Mahaveer Medical College & Research Centre, Moradabad, India, after obtaining permission from the Institutional Ethics Committee, during a period of 6 months (November 2011-April 2012). Healthy young students of the age group 18-25 years, enrolled in the various courses at Teerthanker Mahaveer University were requested to volunteer for the study. 43 female and 56 male students reporting normotensive parents were initially selected for the study (since hypertension is known to have genetic contribution, cardiovascular reactivity may be exaggerated in offspring of hypertensive parents). Basal parameters (height, weight, and resting pulse and blood pressure) of each individual were recorded. Students with body mass index (BMI) lower than 18.5 kg/m^2 or higher than 23.9kg/m^2, resting pulse higher than 90/min, and resting blood pressure higher than 140/90 mm were excluded from the study, as these may affect the CVR to experimental stress. Volunteers reporting history of bone injury in non-dominant hand were also excluded as cold stress may produce pain of longer duration in these individuals.

Written informed consent was obtained from the students who were finally selected for the study, and on whom the experiments were conducted (38 female and 44 male). Since female subjects are more sensitive to pain during ovulation [9], care was taken to perform experiments on female subjects while they were in the menstrual, proliferative, or secretory phase of the menstrual cycle.

Cold pressor task (CPT) was performed by the method described by Kumar et al., [9], with slight changes. The subject was asked to immerse the non-dominant hand in a circulating water bath maintained at 0-1degree Celsius for one minute.

Hand grip test (HGT) was performed by the method described by Jain [10].

For the video game (VG), the subject was given relevant instructions about the game (designed for 15 year olds and above) and allowed a practice time of 5 min. After a 15 min rest, the subject was asked to play the game for 10 min.

With each stress, heart rate and blood pressure of the subject were recorded before and immediately after the experiment.

The data obtained was interpreted in terms of cardiovascular reactivity, i.e., increase in pulse (D-Pulse) and systolic (dSBP) and diastolic (dDBP) blood pressure. Data analysis was carried out by Student's t-test and by ANOVA using Microsoft Excel Program. p-Values less than or equal to 0.05 were considered significant.

RESULTS

Basal parameters of all subjects are presented in [Table/Fig-1]. Female subjects had significantly higher resting pulse. Male subjects had significantly higher resting blood pressure (both systolic and diastolic) compared to the values obtained for female subjects.

The pulse and blood pressure recorded after subjection to stressor were significantly different from the resting values of these parameters in case of CPT and HGT. However, no significant differences from resting values were observed in pulse or blood pressure after VG. For convenience, we have presented the mean ± SD differences in pulse (dPulse), systolic (dSBP), and diastolic (dDBP) blood pressure values. [Table/Fig-2] compares the CVR of female and male subjects to the three different stressors (i.e., CPT, HGT, and VG) by ANOVA. Significantly different values of dPulse, dSBP, and dDBP were obtained in both female and male subjects on subjection to different stressors.

[Table/Fig-3] compares the CVR to each stressor between female and male subjects by unpaired Student's t-test. Significant differences were obtained in dDBP in CPT and HGT, and in dPulse in CPT.

Parameter	Female Subjects (n=38)	Male Subjects (n=44)
Pulse (Mean ± SD)	84.58 ± 6.22	78.00 ± 7.16
SBP (Mean ± SD)	107.63 ± 10.27	114.43 ± 10.84
DBP (Mean ± SD)	77.37 ± 7.75	80.79 ± 6.33

[Table/Fig-1]: Comparison of basal parameters of female and male subjects

	Female Subjects (n=38)		
Parameters	**CPT**	**HGT**	**VG**
dPulse	4.947± 5.633	8.316± 4.685	2.211± 5.089
dSBP	5.737± 5.406	10.263± 6.137	2.474± 5.797
dDBP	5.053± 5.575	9.158± 5.375	0.640± 5.77
	Male Subjects (n=44)		
	CPT	HGT	VG
dPulse	0.182 ± 4.753	6.545 ± 3.914	0.424± 6.981
dSBP	4.909 ± 5.615	8.14 ± 3.77	0.121 ± 4.381
dDBP	1.273 ± 5.427	6.67 ± 4.143	-1.273 ± 4.52

[Table/Fig-2]: Comparison of CVR to the three stressors (CPT, HGT, and VG) in female and in male subjects by ANOVA

Stressor	Parameter	Female Subjects (n=38)	Male Subjects (n=44)
Cold Pressor Task	dPulse	4.947 ± 5.633	0.18± 4.753
	dSBP	5.737± 5.406	4.90± 5.62
	dDBP	5.053± 5.575	1.27± 5.43
Hand Grip Test	dPulse	8.316± 4.685	6.54± 3.91
	dSBP	10.263± 6.137	8.14± 3.77
	dDBP	9.158± 5.375	6.67± 4.14
Video Game	dPulse	2.211± 5.089	0.42± 6.98
	dSBP	2.47± 5.797	0.12± 4.38
	dDBP	0.64± 5.77	-1.27± 4.52

[Table/Fig-3]: Comparison of CVR parameters to CPT, HGT, and VG between female and male subjects by unpaired Student's t-test

DISCUSSION

The female hormone estrogen is responsible for the higher pulse and lower blood pressure values observed in female subjects [Table/Fig-1]. Mathews et al., [3] have reported the resting blood pressure values in black and white subjects of both sexes. The mean values of systolic blood pressure (SBP) are 108.7 (black women), 105.2 (white women), 119.1 (black men), and 116.0 (white men) mm of Hg. In our study, mean SBP of Indian women was 107.6 and of Indian men was 114.4 mm Hg. The mean values of diastolic blood pressure recorded by Mathews et al., are 64.7 (black women), 62.7 (white women), 64.9 (black men), and 64.8 (white men) mm Hg, while we obtained mean values of 77.4 (Indian women) and 80.79 (Indian men) mm Hg. The mean age and BMI of subjects were higher in the study conducted by Mathews et al. The young adults in India have higher blood pressure values than their American counterparts. The situation becomes more alarming when we consider the fact that our subject were screened for normotensive parentage, normal BMI and waist-hip-ratio, and normal resting pulse and blood pressure. Had we included data from all the persons who volunteered for this study, the values of resting blood pressure would have been much higher. This comparison highlights the urgent need to educate families about the dangers of hypertension and the risk factors leading to it. Life style changes must be introduced as early as possible, by seeking the help of schools and higher education institutes, NGOs, primary health centers, etc.

Pulse and blood pressure recorded after CPT and HGT were significantly different from the resting values. These differences were not significant after VG. It is possible that a higher level of VG may have appeared challenging. However, it was not possible for us to teach a higher level of game to the volunteers in the short practice time, especially as many volunteers had not played VG on a laptop earlier.

Both female as well as male subjects showed significantly different CVR to the different stressors. Maximum CVR was shown in response to HGT, and minimum to VG. The cold pressor task is known to produce pain [2,8,9]. However, the CVR produced by CPT in this study was not as high as that produced by HGT. Probably the short time duration (1min) of CPT in this study was not sufficient to produce much change in the heart rate and blood pressure. CPT conducted for longer time durations has been shown to produce larger increments in heart rate and blood pressure [8,9]. Experimental studies designed to study CVR in Indian subjects would show larger increases (and therefore more statistically significant results) if the stressor is CPT or HGT, rather than the video game.

Males are more prone to develop hypertension than females of the reproductive age group. Since exaggerated CVR to stress has been linked with future hypertension [2,3], a higher CVR was expected in male subjects. However, in this study, male subjects showed lower CVR to all three stressors in comparison to females, although the differences were not often statistically significant. Pain sensitivity is known to be diminished in subjects with elevated resting blood pressure [11,12]. It is possible that male subjects, with higher values of resting blood pressure, experience less pain during CPT and HGT and consequently show lower CVR than female subjects. In such a case, the magnitude of normal range of CVR to stress will be different in the male and female subjects. Values of CVR considered normal in females may be exaggerated in males. Further studies on large groups of subjects are required to establish the reference rage of CVR in both female and male subjects.

Koller and Kaley [13] have reported greater increase in blood pressure in males (than females) to challenging achievement tasks like video game. Our results show no significant differences in the BP increases between female and male subjects in response to VG, although the mean values of dPulse, dSBP, and dDBP were lower in male subjects. It is possible that the attitudes of subjects may be different in our study the male subjects may not have found the video game challenging, or the female subjects may have been more competitive in our study. In any case, the CVR to VG was the lowest in both female and male subjects.

Recently, Phillips [14] has shown that diminished CVR to stress

is associated with depression and obesity. The normal range of CVR to stress must be established in both female and male Indian subjects.

CONCLUSION

Indian young adults have higher resting blood pressure than Americans of a slightly older age group, showing an urgent need of educating the common people (at the family level) about the dangers of hypertension.

Maximum CVR was observed in response to HGT in subjects of both sexes, when the time of exposure to stress was 1 min in each case. However, the difference between the CVR observed between females and males was more apparent in case of CPT. CVR to VG was the lowest in case of both females and males.

Thus, future studies designed to study CVR produced by stress may use HGT if the experimenter's focus is on the increase in heart rate and blood pressure, while if the focus is on the gender difference to stress, CPT is the stressor of choice. Video game is not an effective stressor for the Indian young adults as it does not generate sufficient change in heart rate and blood pressure.

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