

*SHORT COMMUNICATION*

INFLUENCE OF AGE AND GENDER ON COLD PRESSOR  
RESPONSE IN INDIAN POPULATION

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**Abstract :** Cold pressor test (CPT) is a simple and well documented laboratory test to evaluate the propensity for hypertension and sympathetic autonomic functions. Role of sex hormones was tested in the present study for the cold pressor response (CPR) in young adults of both sexes and in elderly population. The subjects comprised of young male (n=55), female (n=32) medical students of 17-25 years and elderly males (n=39) and females (n=25) of 50-70 years of age. The CPT was carried out in young and elderly males and females with one minute immersion of one hand in ice cold water (0-4°C). Both in young males and females the absolute rise in SBP and DBP in response to Cold pressor test (CPT) was highly significant, with diastolic percent rise exceeding systolic. In comparison to young males, the females showed greater percent rise in SBP and DBP. Similarly, in elderly groups of both sexes, CPR was associated with significant absolute rise in SBP and DBP with diastolic percent rise more than systolic in males only. Both in young versus elderly males and young versus elderly females comparison yielded comparable percent rise in SBP and DBP. The SBP and DBP percent rise was again comparable between elderly males and females. The greater responsiveness to CPT in young females could be attributed to increased pain sensitivity to cold, and/or genetic and hereditary factors overwhelming the hormonal protection offered by estrogen and nitric oxide (NO).

**Key words :** cold pressor test    vasoreactivity    sympathetic nervous system

INTRODUCTION

The rise in blood pressure in response to localized cold exposure is reflexogenic, mediated through hypothalamus with

augmented sympathetic activity, releasing norepinephrine (NE) at vascular smooth muscle cells (1-4). However, age may influence the quantity of NE released and vascular reactivity (5). Vasoconstriction is

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further accentuated by concomitant release of endothelin 1 (1, 2, 6, 7). Ethnic variations also exist as blacks of both sexes show greater rise in blood pressure (BP) and total peripheral resistance (TPR) in response to CPT as compared to whites (2, 8).

With the aging the process of atherosclerosis may attenuate the production of EDRF i.e. Nitric Oxide (NO) and vessels are likely to exhibit greater constrictor response even to the same levels of vasoconstrictors as in young (9). Further, the influence of gender variation on CPT response is also reported in the literature. (2, 10). To the best of our knowledge these variables have not been studied in Indian Population. We attempted to test these hypotheses by studying cold pressor response (CPR) in young medical students of both sexes and also compared with higher age group of 50–70 yrs.

#### MATERIALS AND METHODS

Subjects comprised of medical students, young males (n=55) in age range of 17–25 (19.6) yrs and young females (n=32) in age range of 17–22 (19.3) yrs. The elderly population included males (n=39) aged 50–70 yrs (55.3) yrs and females (n=25) aged 50–70 (55.16) yrs. The younger population hailed from upper middle class and upper class of society sharing common hostel accommodation and food. None of the young volunteers were smokers or suffering from any organic disease. They were also not on any medication affecting heart or circulation.

The elderly population belonged mostly to middle-middle class. They were either normal or non cardiac patients. By a questionnaire any intake of cardiac, antihypertensive, bronchodilators, analgesic and antihistaminic drugs were excluded. A written informed consent was obtained from

all the volunteers and non invasive nature of experimental protocol was explained to them. The study plan was approved by Ethics Committee of the Institution.

#### Experimental protocol

All the student volunteers reported to the laboratory between 2–4 pm in batches. Their height and weight were recorded and body surface area (11) and body mass index (BMI) were calculated. The subjects were allowed to relax on the couch for 15 minutes. Their Basal Systolic and Diastolic Blood Pressure (SBP & DBP) were recorded by sphygmomanometer. Although, minor variations in BP do occur during two phases of menstrual cycle a general single reading was taken in young females, lest comparison of CPR would have been irrelevant with large number of elderly post menopausal females of 50–70 years. Subjects were asked to immerse their left hand in a bowl containing ice cubicles and water (0–4°C) up to wrist for one minute. The SBP & DBP were again recorded in contralateral hand at the end of one minute. The anthropometric parameters and cold pressor response in the elderly subjects were recorded in the clinic.

#### Analysis of data

All the data were expressed as Mean±SD. Intra group comparisons were made between absolute rises in SBP and DBP from their baseline values in response to CPT. The percent rise in SBP & DBP to CPT were also compared.

For inter-group comparison, the percent rise in SBP and DBP of different groups to CPT were compared. The data was analysed by one way Anova with post hoc test. Statistical significance was assigned for all the values of P<0.05.

## RESULTS

Results are summarized in Table I and Table II. The anthropometric parameters of all the groups were fairly similar (Table I). The cold pressor test elicited a significant absolute and percent rise in SBP and DBP in young males and females (Table II). In both DBP percent rise exceeded systolic percent rise. In comparison to males the females showed greater percent rise in SBP and DBP (Table II).

Similarly, the elderly subjects of both sexes also exhibited significant absolute and percent rise in SBP and DBP. There was no

significant difference between elderly males and females in percent rise of SBP and DBP. Comparison between young and elderly males and young and elderly females revealed comparable increments in SBP & DBP percent rise (Table II).

## DISCUSSION

The BMI of all groups of our subject population was evenly matched (Table I). The CPR in both genders of young and elderly are in conformity with earlier observations that cold stress increases both systolic and diastolic blood pressure significantly (1-4). Most of the previous authors have reported

TABLE I: Age and anthropometric profile of different study group subjects.

Parameters	Young males (n=55)	Young females (n=32)	Elderly males (n=39)	Elderly females (n=25)
Age (yrs)	19.61±1.7	19.3±1.0	55.3±4.7	55.16±4.52
Weight (kg)	69.78±8.11	58.61±9.98	64.34±10.92	58.40±14.07
BMI (kg/m <sup>2</sup> )	24.16±2.46	23.45±3.28	23.23±3.42	25.48±5.10

Data presented are mean±SD.

TABLE II: Basal systolic blood pressure (SBP), basal diastolic blood pressure (DBP) (mm Hg) and their cold pressure responses (CPR, after 1 min) in different study group subjects.

Parameters	Young males (n=55)	Young females (n=32)	Elderly males (n=39)	Elderly females (n=25)	Intra-group	P Values ANOVA	Inter-group	P Values ANOVA
Basal SBP	124.69 ±10.18	118.81 ±5.90	123.12 ±17.80	126.08 ±17.21	Young males – Basal SBP Vs 1 min SBP Basal DBP Vs 1 min DBP % SBP Vs % DBP	P<4.22 E-08 P<3.88 E-08 P<0.008	Young males Vs Young females % SBP Vs % SBP % DBP Vs % DBP	P<0.022 P<0.001
CPR SBP	136.29 ±10.44	132.94 ±5.90	134.51 ±22.21	140.12 ±20.55	Young females – Basal SBP Vs 1 min SBP Basal DBP Vs 1 min DBP % SBP Vs % DBP	P<7.77 E-14 P<3.40 E-11 P<.001	Elderly males versus elderly females %SBP VS% SBP % DBP Vs% DBP	P<0.17 P<0.41
% change in SBP	9.44 ±4.81	12.04 ±5.41	9.18 ±6.17	11.24 ±7.24	Elderly males – Basal SBP Vs 1min SBP Basal DBP Vs. 1 min DBP % SBP Vs % DBP	P<0.014 P<0.0001 P<0.0427	Young males Vs Elderly males % SBP Vs % SBP % DBP Vs % DBP	P<0.81 P<0.96
Basal DBP	84.62 ±9.16	77.72 ±5.62	80.10 ±9.89	81.52 ±9.40	Elderly females- Basal SBP Vs 1min SBP Basal DBP Vs 1min DBP %SBP Vs %DBP	P<0.011 P<0.0006 P<0.238	Young females Vs Elderly females % SBP Vs % SBP % DBP Vs DBP	P<0.62 P<0.17
CPR DBP	94.80 ±8.88	91.19 ±7.63	89.89 ±11.81	92.92 ±12.60				
% change in DBP	12.33 ±6.43	17.46 ±7.67	12.46 ±7.64	14.23 ±10.22				

Data presented are Mean±SD. Intra-group and inter-group comparisons were done by one-way ANOVA.

a greater CPR for both blood pressures and TPR in males than in females irrespective of age (2, 12) and this was attributed in part to greater release of endothelin - 1 in males (2, 7, 13).

In a recent report also in equally matched males and females, the responses of an increase calf vascular resistance (CVR) to cold pressor were significantly smaller in women than in men despite similar increments in efferent sympathetic nerve activity, thus suggesting differential NE release or role of other vasoreactive substances, in two sexes (14)

However, the greater CPR in young females of present study has contradicted the presumed hypothesis that the estrogen should attenuate the vasoconstrictor response by a) retarding the process of atherosclerosis due to its hypocholesterolaemic effects (15), b) by increased production of NO (15), and decreased production of endothelin 1 (2, 13). We have observed greater diastolic rise than systolic in young females which is contrary to the earlier study (10) on twins, where females showed greater vascular reactivity for systolic blood pressor to Cold Pressor Test (CPT). Akin to our observations these authors (10) also reported greater vascular reactivity to CPT in females than in males. In this regard young females of our study have responded more closely to young African females to CPT (12). However, we agree with the proposition (10) that in young females the genetic factors may be more important.

The exaggerated CPR in young females of our study could be attributed to following probable factors, a) As proposed earlier (10) the genetic factors may overwhelm the protection offered by hormone estrogen in females, b) It is quite likely that other

vasoreactive substances viz. prostaglandins and angiotensin may be getting released in different proportion in two sexes by cold exposure (1), c) The alpha adrenoceptor population in female vascular smooth muscle may exceed that in males thus they may contract more to same levels of NE released during CPT in males (5), d) The young upper middle class and upper class Indian females, lead a more protected life as compared to their male counter part, who by nature are extrovert and exposed more to socio-environmental stresses with better adaptation to them. It is of common knowledge that north American and European young females lead a more outdoor life and they may show diminished response to stress. However, these propositions are highly conjectural and need confirmation in future studies.

The CPR for SBP and DBP in elderly males was not significantly different ( $P < 0.5$ ) from young males. This is contrary to a previous report (5) where increased norepinephrine responsiveness and up regulation of adrenergic tone was suggested for greater CPR in elderly males as compared to young males. In another study (16), NE responsiveness of cutaneous blood vessels (Vasoconstriction) was found to be less in elderly people as compared to young and this was attributed to less availability of  $Ca^{2+}$  and decreased function of adrenoceptors. However, the observations and explanation of both these authors (5, 16) are mutually contradictory. Our observations suggest equal vasoreactivity in young and old except in young females presumably the genetic factors (10) are overriding the advantages conferred by biochemical (hypocholesterolemic; 15) and humoral (Increased NO; 15 and decreased endothelin (2, 13) factors. Alternatively, young female subjects may be

hypersensitive to pain sensation evoked by CPT (17, 18).

Evolutionarily, the black (Africans) and brown (Asian Indians) are product of tropical climate, while whites (North Americans and north Europeans) have evolved in temperate zones therefore, the genetic regulation was diverted towards better adaptation to cold for the whites and lesser to black and brown. It is evident from the present study that vascular reactivity is gender related. However, the exact mechanism remains to be elucidated and lack of hormonal assay in

this study is a limitation to be addressed in the future.

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