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A Correlative Study of Cardiovascular Response to Sustained Hand Grip in Healthy Young Adults with Fat Free Mass Index

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Abstract: *The cardiovascular changes like increase in heart rate (HR) and mean arterial pressure(MAP) following isometric contraction (sustained hand grip) are mediated largely by the sympathetic nervous system which is activated by both central command to autonomic system and by reflexes arising within the contracting muscle .Body mass index (BMI) has been used since long to asses health and obesity .But BMI has the limitation of not distinguishing between fat and fat free mass. Hence the validity of BMI as an indicator of body fat in cardiovascular risks is recently challenged. So the present study was taken up with an objective to find out the cardiovascular changes during sustained hand grip and their relation with BMI, body fat percentage (BF%) , fat free mass(FFM) and fat free mass index(FFMI).The study included 50 healthy young adults (31male & 19female) of age group 17-25 yrs. Their height and weight were measured. Basal heart rate and blood pressure were recorded. BF% was measured by OMRN body fat Monitor. They were subjected to hand grip at 30% max. Voluntary contraction (MVC) for 3 minutes. HR & BP were recorded at the end of 3 min . SBP&MAP showed significant correlation with FFM and FFMI but it was insignificant with BMI.*

Keywords*: Sustained hand grip, Body mass index, Body fat %, Fat free mass, Fat free mass index.*

I. Introduction:

The cardiovascular changes like increase in heart rate (HR) and mean arterial pressure(MAP) following isometric contraction (sustained hand grip) are mediated largely by the sympathetic nervous system which is activated by both central command to autonomic system and by reflexes arising within the contracting muscle [1] .Obesity which is considered as major public health problem is also one of the major risk factors for heart diseases and is associated with altered autonomic function giving rise to cardiovascular dysfunction [2] .

Body mass index (BMI) has been used since long to assess health and obesity. But it includes both body fat and fat free mass (chief structural and functional component of the human body). A Person with high BMI due to high fat free mass (FFM) will have better cardiovascular efficiency than a person with high BMI due to high body fat% (BF%) . Hence the validity of BMI as an indicator of body fat (BF) in cardiovascular risks is recently challenged.[3]

So the present study was taken up with an objective to find out the cardiovascular changes during sustained hand grip and their relation with BMI, body fat percentage (BF%) , fat free mass(FFM) and fat free mass index(FFMI).

II. Materials And Methods:

This prospective study was conducted in the PG Research Lab of Dept. of physiology, MKCG Medical College, Berhampur during the period from Nov. 2011 to Oct. 2012 after due approval from the Institutional Ethics Committee. Study included 50 healthy young adults both male(31) and female(19) within age group of 17 to 25 years. The experimental protocol was explained to all the subjects and written consent was obtained from all of them. The subjects with history of smoking, asthma, any other past or concurrent pulmonary disease and any other systemic disease were excluded from the study. The study was conducted after a minimum of 2 hours of light breakfast. To avoid circadian variation all study were conducted between 10 am to 12 noon.

Body weight was recorded in kilograms on empty bladder and before lunch wearing light weight clothing and bare foot with "Prestige Digital weighing scale''. Standing height was recorded using stadiometer to the nearest 0.1cm. BMI was calculated using Quetlet's index, BMI=Weight(in Kg)/ Height(in meters) ^{2} .

Body fat percentage was measured by "Bioelectric Impedance analysis'' technique using OMRON Body Fat Monitor(HBF-306).FFM and FFMI were calculated from BF% as follows-

FFM=(100-BF%)/100×Weight (in Kg) FFM=FFM/Height (in m ^{2})

The basal heart rate (HR) and blood pressure (BP) of the study group were recorded by Clarity Med (PMS 320) Cardiac Monitor. Each subject was asked to grip the Med Scale Hand Grip Dynamometer with their dominant

hand at 30% of maximum voluntary contraction (MVC) for three minutes. Then HR and BP (both systolic and diastolic) were recorded at the end of 3 mins. MAP was calculated.

The data obtained were analysed using statistical software (Graph Pad Prism version 6).The change in cardiovascular parameters was analysed by paired t-test and their relation with BMI,BF%,FFM and FFMI was analysed by using correlation and linear regression methods.

III. Observation And Analysis:

Mean anthropometric measurements are shown in Table1

TABLE 1.

Anthropometric parameters	MALE(n=31)	FEMALE(n=19)
Age in yrs	19.64±1.06	19.1±1.21
HEIGHT(in cms)	165.86±4.68	154.81± 5.83
WEIGHT(in kg)	67.27±9.92	57.36±8.40
BMI(Kg/m^2)	24.45±3.54	23.89±3.14
BF%	24.47±5.86	32.23±4.08
FFM(Kg)	50.91±6.33	38.60±3.90
FFMI(Kg/m^2)	18.51±2.26	16.08±1.11

Though in both the groups BMI is within normal range (24.45 in Female, 23.89 in Male), The BF% are in higher range ie 24.47 in male (normal(9-19%) and 32.23 in female (normal(21-33%)[4].

TABLE 2.

Basal cardiovascular parameters and changes after 3 min of sustained hand grip.

PARAMETERS	BASAL	3 Min	P Value
HR(Beats/min)	76.1±7.83	112.06±11.30	<0.0001
SBP(mm of Hg)	117.24±10.47	142.78±11.32	<0.0001
DBP(mm of Hg)	77.28±7.07	90.86±13.72	<0.0001
MAP(mm of Hg)	90.6±7.20	108.16±9.93	<0.0001

After 3 min of sustained hand grip all the cardiovascular parameters under study (HR, SBP, DBP and MAP) were increased which was statistically highly significant($p<0.01$ significant).

Heart rate after 3 minutes of sustained hand grip was statistically analysed for any correlation with BMI, BF%, FFM and FFMI but no significant correlation was observed .

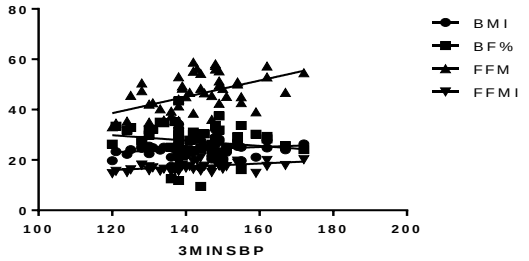
TABLE3.

correlation of SBP with BMI,BF%,FFM and FFMI.

CORRELATION	3 min SBP vs BMI	3 min SBPvsBF%	3 min SBP vs FFM	3min SBP vs FFMI
Person r				
r	0.1711	-0.1880	0.4954	0.3825
95% confidence level	-0.1127 to 0.4921	-0.4432 to 0.09540	0.2518 to 0.6801	0.1165 to 0.5973
R square	0.02928	0.03534	0.2455	0.1463
P value				
P (two tailed)	0.2348	0.1911	0.0003	0.0061
P value summary	ns	ns	***	**
Significant?	No	No	Yes	Yes

When SBP at 3 mins was correlated with the BMI,BF%,FFM and FFMI ,no significant correlation of SBP was observed with BMI or BF% but it was highly significant with FFMI and very highly significant with FFM.

However, no significant correlation was observed with DBP.



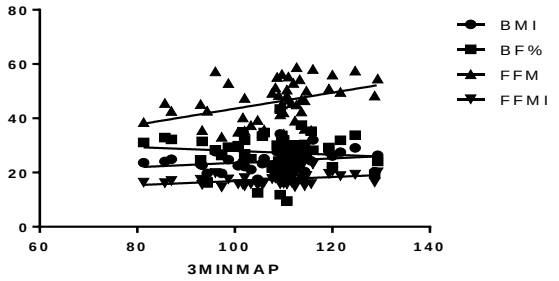
Graph 1.Correlation of 3 min SBP with BMI,BF%,FFM and FFMI.

TABLE 4

Correlation of MAP with BMI,BF%,FFM and FFMI.

CORRELATION	3 min MAP vs BMI	3min MAP vs BF%	3 min MAP vs FFM	3min MAP vs FFMI
Person r				
r	0.2369	-0.1070	0.3965	0.3909
95% confidence level	-0.04440 to 0.4835	-0.3743 to 0.1767	0.1327 to 0.6078	0.1263 to 0.6036
R square	0.05614	0.01145	0.1572	0.1528
P value				
P (two tailed)	0.0976	0.4595	0.0044	0.0050
P value summary	ns	ns	**	**
Significant?	No	No	Yes	Yes

While MAP showed insignificant correlation with BMI and BF%, its correlation with FFM and FFMI was highly significant.



Graph 2: correlation of MAP with BMI,BF%,FFM &FFMI.

IV. Discussion

In our study cardiovascular parameters like HR, SBP, DBP and MAP were significantly increased following isometric contraction .Similar changes were observed by A R Lind et al [5] ,E Cheneau et al[6], S Sucharita et al [7] and G M Goodwin et al [8] . We found out that SBP and MAP correlated better with FFM and FFMI than BMI and BF%.

The fat free mass which consists of muscle mass , bone and water is considered the chief structural and functional component of body and FFMI includes the height/stature of body. FFMI= (FFM/height in mt^2). Two Mechanisms could be responsible for the role of muscle mass in the cardiovascular response following isometric contraction [9 10]

1.Central command theory; It involves activation of higher brain centres on the volition and initiation of muscular contraction. Greater the no of motor units activated to accomplish a particular contraction ,greater the integration of such a signal by central controlling neurons, the greater will be the central command input to the brainstem cardiovascular centre and therefore the greater the cardiovascular response during isometric exercise.

2. Exercise pressor reflex theory: suggests that there is a reflex stimulus originating in nerve endings in the contracting muscles. Thus during sustained isometric contraction the greater the number of motor units activated, greater the activation of afferent nerve fibres to the contacting muscle suggesting increase cardiovascular response is related to muscle mass. This signifies the important role played by FFM and FFMI on cardiovascular changes following isometric contraction. Similar findings were observed by M Hulens et al.[11]

V. Conclusion:

Our study shows SBP & MAP are positively correlated with FFM and FFMI (Highly significant) & negatively correlated with BF%. The correlation with BMI is insignificant. Again our study supports the fact that muscle mass and strength has positive effect on cardiovascular function .So the cardiovascular risk assessment by BMI alone can be misleading and better parameters like BF%, FFM, FFMI can be effectively used. The cardiovascular efficiency can be improved by increasing the fat free mass through regular activities like aerobic exercise.

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