

Comparison of Exercise Capacity (VO₂ max) of Different Age Group Participants with Left Ventricle Diastolic Function

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ABSTRACT

Introduction: Exercise capacity (VO₂ max) is affected by many factors, for example cardiorespiratory fitness, obesity, comorbidities (hypertension and metabolic syndrome), and advanced age. Identification of factors that can affect exercise capacity is extremely important because its reversals can enhance the patients' life quality and have an impact on their survival as their exercise capacity is related to prognosis in healthy people and in heart disease patients.

Material and methods: The cross-sectional study was done in “Haldiram and Moolchand Heart Centre”, PBM Hospital, S.P. Medical College, Bikaner by estimating exercise capacity (VO₂ max) by Bruce protocol through treadmill test in different age groups and left ventricle diastolic functions determined by echocardiography were graded into normal, mild to moderate and severe diastolic dysfunction. Exercise capacity (VO₂ max) of different age groups was compared with different grades of left ventricle diastolic function.

Results: There was significant difference between the exercise capacity (VO₂ max) of participants with normal diastolic function and abnormal diastolic function with respect to different age groups

Discussion: Exercise capacity declines with increase in age but this decline was steeper in abnormal diastolic function as compared to normal diastolic dysfunction. Diastolic function impact VO₂ max by their role in producing optimum cardiac output. The preservation of ample left ventricular filling for ensuring proper heart performance during exercise requires the capacity to attain rates of diastolic filling higher than the rates of ejection during the systole.

Conclusion: We have seen that a significant difference between diastolic dysfunction and age that rises steadily with age, with a steeper decline in VO₂max of abnormal diastolic function relative to those of normal diastolic function.

Keywords: exercise capacity: VO₂max, diastolic function, exercise capacity, age

INTRODUCTION

Exercise is considered as a stressful situation that results in evident variations in functions of body especially nervous, respiratory and cardiopulmonary activities.

Exercise is thus considered to be a way for discovering an individual's physiological responses and physical capabilities.¹ Furthermore, Exercise capacity is described by way of “the maximum oxygen uptake for

a given workload” as well as thus, expressed either as VO₂ max (the greatest rate of oxygen uptake during exercise as well as used by the body) or METS (metabolic equivalent or oxygen consumption’s basal rate’s multiples while a person being at rest that is for an average adult 3.5 ml/kg/min).² VO₂ max is affected by many factors, for example cardiorespiratory fitness, obesity, comorbidities (hypertension and metabolic syndrome), and advanced age.^{3,4,5} The Bruce protocol estimate endurance from exercise duration Exceptionally, the more the subject can keep running on the treadmill, the lesser are chances of subject of death from cardiovascular disease.

Current clinical trials have shown that exercise capacity (VO₂max) and diastolic function parameters are interrelated significantly, particularly in cardiovascular disease.⁶ Latest tissue development doppler imaging enhanced echocardiographic precision in detecting early diastole left ventricular diastolic dysfunction and estimating filling pressures.⁷ Intervening factors contributing to endurance have also led to improvement in morbidity and mortality, however aging being a universal and a non modifiable factor cannot be directly intervened. Hence if we can recognize major modifiable factors affecting endurance with aging, intervention can be targeted to improve endurance and thereby nullify the declining function and delay overall mortality. Aging, an unavoidable phenomenon, is linked with a gradual decrease in functions as well as functional capacities of every body system. Among the aging’s major effects is a reduction in aerobic exercise capacity (decline in physical fitness level). Decline in endurance with age is well documented but the factors that contribute to this decline are a matter of debate for many years. This requires to be completed so that if a modification is performed in age associated reduction in exercise capacity.⁸

Aims and objectives

To study exercise capacity (VO₂ max) in different age groups with the left ventricle diastolic functions.

MATERIALS & METHODS

This cross-sectional study was conducted at “**Haldiram and Moolchand Heart Centre**”, PBM Hospital, S.P. Medical College, Bikaner. This study was approved by Institutional Ethical Committee and Institutional Research Board.

Study subjects: The study was organized on 323 subjects for a period of one year from 1 August 2017 to 1 August 2018 and each and every patient whoever fits my inclusion and exclusion criteria was enrolled in the study after taking a consent. An exclusion criterion was subject having any respiratory disease; atrial fibrillation/flutter; cardiac valve disease, heart failure, or any coronary artery disease. Furthermore, for reproducing Doppler, M mode, and cross-sectional studies sufficient quality echocardiographic images are required.

Study Procedure: Required information according to study was gathered from the study participants’ hospital record and were categories into young (18-35 years), middle age (36-55 years), older age (more than 55 years).

Anthropometric variable such as weight and height was attained as well as BSA and BMI was analysed. For calculating BMI, following formula is used = “*weight (kg)/height (m).*” For calculating BSA, following formula is used = “*0.0001x71.84 x (weight in kg)^{0.425} x (height in cm)^{0.725}.*”

Evaluation of left ventricle diastolic function:

Apical 4-chamber view is used for obtaining Doppler transmitral inflow with 3.5 MHz frequency and sweep time 2-12 seconds. The algorithm of Khouri et al has updated the definition of diastolic function, and the left atrial volume has been assessed in our evaluation as it is a sign of diastolic dysfunction according to Gilman g and Tsang ST rather than pulmonary vein flow measurement.^{9,10,11} The following

parameters were calculated to grade diastolic functions.

1. The ratio E/e_′, a left ventricular filling pressures measurement, was possible in every patient which are at rest.
2. Left atrial size's 2-dimensional measurement.
3. The baseline resting assessment includes late (A) and early (E) mitral inflow velocities pulsed-wave Doppler measurements.

Resting diastolic function was categorized as severe dysfunction (restrictive), moderate dysfunction (pseudonormal), mild dysfunction (impaired relaxation), or normal. The different grades of diastolic functions were classified according to below given criteria:

Classification of Diastolic Function

Variable	Normal	Grade I (Mild)	Grade II (Moderate +Severe)
E/A	>0.75	<0.75	0.75 – 1.5
LAVI	<28	<28	>28
E/e′	<10	<10	>10

Treadmill Exercise Test

The CTMT 12 lead device was used for performing the treadmill exercise test. A multi-stage treadmill testing of maximum exercise was conducted using the Bruce protocol (Bruce. R, A.1972). According to Bruce protocol speed of treadmill and inclination (grade) was increased every three minutes and ECG will be recorded in each phase of the protocol.

The test will be terminated with target heart rate achievement i.e. 220-age and time taken for achieving the target rate was used to calculate VO₂ max by following formula.

VO₂ max is calculated according to the equation stated by Bruce which is as follows “In male, VO₂ max = 14.8 - (1.379 × T) + (0.451 × T²) - (0.012 × T³) whereas in

women, VO₂ max = 4.38 × T - 3.9 (“T” represents test’s total time articulated in minutes as well as minute fractions considered for achieving target heart rate).”

Statistical Analysis

Statistical analysis is done by transforming the data into MS EXCEL worksheet and SPSS is used to extract meaningful outcome and subjecting it to draw percentages, mean and deviations and data was analysed using single factor analysis of variance ANOVA test and two sample independent t test assuming unequal variances at 5 % Level of Significance.

RESULT

Table 1: Descriptive Statistics of Anthropometric Variables

VARIABLES	MEAN ± SD	RANGE/RATIO
Age (years)	48 ± 11.9	15 – 72
Male / Female	217/106	2.05:1
Height (cm)	163.4 ± 8.20	145 - 186
Weight (kg)	66.5 ± 10.5	35 -115
BMI (kg/m ²)	24.8 ± 3.1	16.6 - 36.7
BSA	1.71 ± 0.16	1.20 - 2.30

Table 1 showed the descriptive statistics of anthropometric variables.

Table 2: Comparison of VO₂max in different age groups

Age Group	N	95%CI		Mean ± SD	F value	P value
		Lower CI	Upper CI			
15-35 years	49	31.3	34.6	32.9 ± 5.7	16.3	0.00*
36-55 years	188	30.1	32.3	31.2 ± 7.6		
> 55 years	86	25.4	28	26.7 ± 7.2		

*p<0.05, significant at 5% Level of Significance

Figure 1: Scatter Diagram of Exercise Capacity (VO₂ max) (ml/kg/min) VS AGE GROUPS

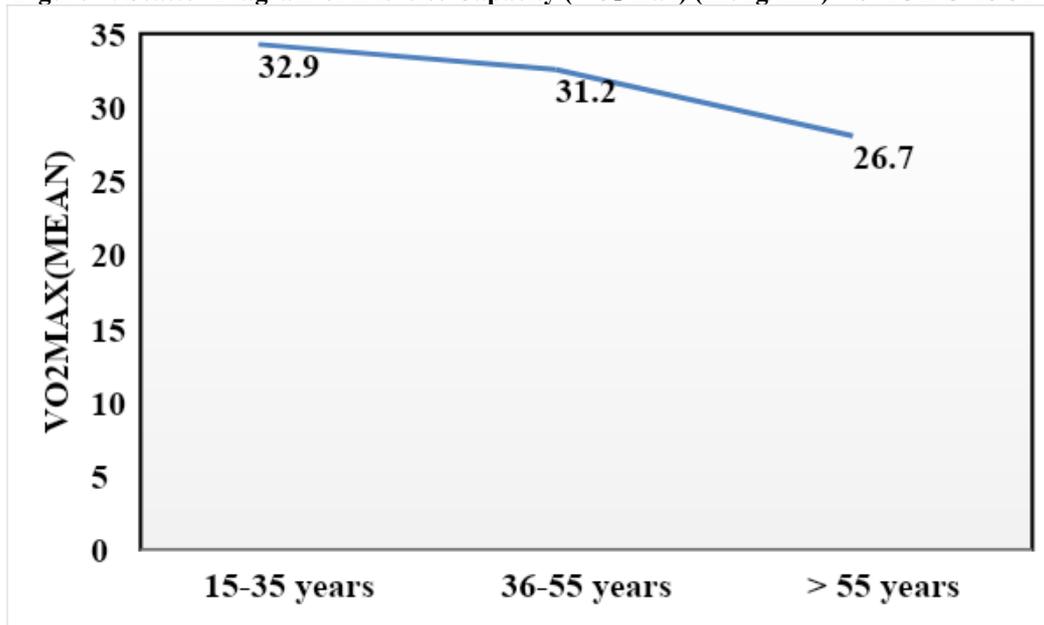


Table 2 (figure 1) showed that the average of VO₂ max of different age groups 15-35 years, 36-55 years and >55 years found

statistically highly significant using Single Factor Analysis of Variance ANOVA test.

Table 3: Echocardiography characteristics according to grading of diastolic functions.

Variables	Normal n = 210	Mild n = 62	Moderate n = 51
EDVI	46.4 ± 6.9 ^ψ	42.9 ± 6.7* ^ξ	46.7 ± 6.5 ^ψ
Left atrial volume index, ml/m ²	15.4 ± 3.25 ^ξ	16 ± 3 ^ξ	28.7 ± 0.6* ^ψ
E	0.8 ± 0.13 ^ψ	0.6 ± 0.12* ^ξ	0.8 ± 0.12 ^ψ
A	0.6 ± 0.19 ^ψ	0.9 ± 0.08* ^ξ	0.6 ± 0.14 ^ψ
E/A	1.32 ± 0.51 ^ψ	0.65 ± 0.07* ^ξ	1.28 ± 0.20 ^ψ
e'	0.09 ± 0.01 ^ψ	0.75 ± 0.31* ^ξ	0.58 ± 0.28* ^{ψξ}
E/e'	7.81 ± 1.4 ^{ψξ}	6.7 ± 1.7* ^ξ	11.7 ± 1.4* ^ψ

Table 3: Pairwise comparisons of continuous data performed with analysis of variance using Tukey honestly significant

difference *p<0.05, ^ψ p<0.05 and ^ξ P<0.05 compared to patients with normal diastolic functions

Table 4: Comparison of VO₂max of different age group participants with diastolic function and abnormal diastolic function.

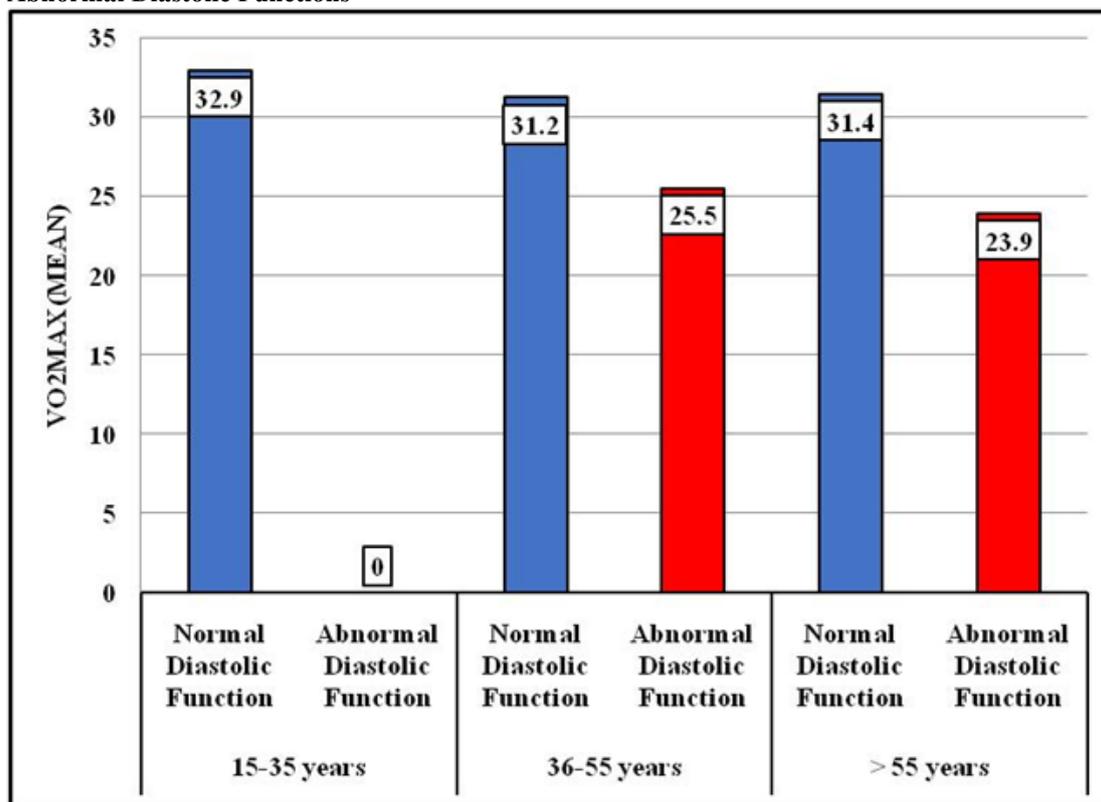
Age Group	Diastolic Function	N	95%CI		Mean ± SD	t value	P value
			Lower CI	Upper CI			
15-35 years	Normal Diastolic Function	49	31.3	34.6	32.9 ± 5.74	NA	NA
	Abnormal diastolic Function	0	0	0	0		
36-55 years	Normal Diastolic Function	188	30.1	32.9	31.2 ± 7.6	7.34	0.00*
	Abnormal diastolic Function	59	34.5	25.6	25.5 ± 4.1		
> 55 years	Normal Diastolic Function	32	28.8	34.02	31.4 ± 7.2	5.58	0.00*
	Abnormal diastolic Function	54	23.01	24.8	23.9±3.7		

Wherein “*p<0.05, significant at 5% Level of Significance”

Table 4 represent the significance difference between the VO₂ max of participants with normal diastolic function and abnormal

diastolic function with respect to different age groups.

Figure 2: Bar Diagram: Exercise capacity (VO₂ max) (ml/kg/min) vs Age Group Classified into Normal and Abnormal Diastolic Functions



DISCUSSION

In present study table 1 includes minimum age of 15 years and maximum age of 72 years of participants under study with mean age 48 years and standard deviation 11.9 years. Male to Female Ratio was (2.05: 1). The average body mass index was recorded as 24.8 kg/m² with \pm 3.1 kg/m² of deviation. Average BSA was observed 1.71 \pm 0.16.

Table 2 (Figure 1) showed that the average VO₂ max of different age groups 15-35 years, 36-55 years and >55 years found statistically highly significant using single factor analysis of variance ANOVA test.

Table 3 showed normal diastolic function has been seen in 210 (65%), mild diastolic dysfunction in 62 (19%) and moderate dysfunction in 51 (15%) subjects. Moderate and Severe diastolic dysfunction were merged for the purpose of analysis. Result so depicted were pair wise comparisons of continuous data performed with analysis of variance using Tukey honestly significant difference *p<0.05, ^ψ p<0.05 and ξ P<0.05 compared to patients with normal diastolic function”.

In present study above table 4 (figure 2) represent the significant difference between the average VO₂ max of participants with normal diastolic function and abnormal diastolic function with respect to different age groups.

In present study above table 4 (figure 2) statistical analysis was done using two sample independent t test assuming unequal variances at 5 % Level of Significance. It was found that between 15-35 age group 49 participants have normal diastolic function with 32.9 mean VO₂max and 5.74 Standard deviation. The VO₂max of the age group 36-55 years and more than 55 years between normal and abnormal diastolic function was highly significant. (t= 7.34, p = 0.00 > 0.05), (t = 5.58, p= 0.00 >0.05).

Oldershaw PJ et al in 1983 indicates that irregularities with diastolic relaxation and the filling of the left ventricle may lead to filling values that may be sufficient for a proper cardiac output, while ventricular systolic properties may be normal.¹²

Increase in total left ventricular filling pressure during resting and training is

identified as E/e of 15, or greater by Burgess MI et al and Ommen SR et al.^{13,14} Diastolic function impact VO₂ max by their role in producing optimum cardiac output. The preservation of ample left ventricular filling for ensuring proper heart performance during exercise requires the capacity to attain rates of diastolic filling higher than the rates of ejection during the systole. Our research indicates that a significant relationship between age and diastolic dysfunction occurs, which gradually increases the absolute decrease in the exercise capacity of person with diastolic function vs people with normal diastolic function.¹⁵

Levy WC (1993) clarified that training increases the diastolic function of healthy people, seeing a spike in peak diastolic filling rates. However, while training improves the endurance in patients with diastolic dysfunction, the results of training on the diastolic function are not apparent.¹⁶

CONCLUSION

One of the most debilitating effects of aging is the decline in VO₂max. Our results indicate that increase in age is related to a progressive decrease in VO₂max

Moreover, we observed that, in spite of aging a high fitness capacity comparative to that of younger fit individuals can be maintained if the person undergoes regular physical exercise (as per recommended guidelines for the particular age and associated clinical conditions). We also shown that a significant association is between VO₂max and age that rises steadily with age, with a steeper decline in VO₂max of abnormal diastolic function relative to those of normal diastolic function.

Life expectancy is growing, resulting increased age is related to independence loss and growing disabilities. With increasing age, it is common to have the chronic conditions. Maintaining cardiovascular fitness will not only help in increasing longevity and reducing premature death but, more significantly, it might reduce the

illness period so that until near death people will be healthy.

Declaration by Authors

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