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Original Research Article

Assessment of Cardiorespiratory Fitness in Asian Indian Men with Diabesity

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ABSTRACT

Background: Diabesity patients are at high risk for cardiovascular morbidity and deaths. The combination of type 2 diabetes and obesity causes 5 to 8 times progressive increase in death rates. so early detection and treatment are very important. Cardiorespiratory fitness (CRF) is the most powerful predictor for risk of mortality than other established traditional risk factors like obese, type 2 diabetes, high blood pressure, dyslipidemia, smoking history, cardiac diseases. Low cardiorespiratory fitness increases cardiovascular mortality.
Materials and Methods: Total 30 subjects with Group A - Diabesity patients (n=15) and Group B - Normal healthy subjects (n=15) were included in this study according to height, weight, BMI, WC, HbA1c. VO2max was evaluated by 6minutes walk test to assess the cardiorespiratory fitness and compared between the groups.
Results: Results showed that there is a statistically significant decrease in VO2max in group A-Diabesity patients (VO2 max mean values 21.74 ml/kg/min) when compared to Group B-Normal healthy subjects (34.21 ml/kg/min) with p- Value 0.0000 which is less than 0.05.
Conclusion: This study concluded that cardiorespiratory fitness was lower in diabesity patients when compared to normal healthy subjects. Hence physiotherapy exercises should be incorporated in Asian Indian men with diabesity to improve CRF.

Key Words: Diabesity, Diabetes, Obesity, Cardio-respiratory fitness, VO2 max.

INTRODUCTION

Obesity is a major health problem globally. India is facing an increasing epidemic of obesity during the last century. According tothe Indian Council of Medical Research-India Diabetes (ICMR-INDIAB), in India the prevalence of generalized obesity is 21% with body mass index (BMI) >25kg/m^2, abdominal obesity is 24.8% with waist circumference (WC) >90cm(men) and >80 cm(women) and combined obesity accounts for 28.6% (generalized with abdominal). In India 199 million individuals are having obesity. [1] According to the

recent International diabetes Federation 2017 (IDF), the global prevalence in 2017 is 451 million diabetes and assumes to rise to 693 million adults by 2045. The highest prevalence of diabetes is in China with 114 million adults followed by India, the prevalence is 73 million people and in the United States of America with 30 million diabetes. [2] The combined epidemics of obesity and diabetes were termed as diabesity. Diabesity epidemics are threatening India. Diabesity in India is occurred due to increased insulin resistance, altered environmental factors, rapid industrialization, and urbanization because of the altered food habits and inactive lifestyle. [1] Diabesity is a better term for Indian diabetes and diabesity prevalence is more in urban as well as rural areas of India. [3]

According to WHO, overweight and obesity accounts for forty-four percent of the type 2 diabetes mellitus patients, twenty-three percentage of the ischemic cardiac diseases, and seven to forty-one percentage of cancer-related disorders. [4,5] Type 2 diabetes mellitus is more strongly related to obesity, and the prevalence of diabesity is expected to double in 2025 to 300 million people. [6]

Increase in the prevalence of diabetes and cardiovascular diseases in Indians are due to 'Asian Indian Phenotype' with reduced generalized obesity (BMI) and the increase in Central obesity (WC and waist hip ratio (WHR)). [7] Diabesity is a synonym for Indian diabetic patients because Asian Indians develops type 2 diabetes mellitus at early age with lower BMI and greater waist circumference (WC) compared to other ethnic groups, because of lean skeletal muscle mass and altered fat distribution pattern of South Asians. It is observed that increase in overall adiposity mainly intra-abdominal visceral adiposity, trunk and deep subcutaneous abdominal adiposity is higher in South Asians and hepatic fat deposition is 2 times higher in Asian Indians which leads to fatty pancreas and liver causing insulin secretory deficit and insulin resistance causing type 2 diabetes mellitus and cardiovascular diseases. Lower levels of CRF are the main risk factor for type 2 diabetes as well as cardiovascular diseases (CVD). LA Lesser et al states that there is a negative relationship between V02max and abdominal obesity; increase in CRF is associated with less BMI, WC and abdominal obesity in South Asian. [8,9]

Both obesity and type 2 diabetes increase cardiovascular deaths. Diabetic prevalence is three to five times higher in obese patients than normal weight individuals. Evidence states that cardiorespiratory fitness is a very important and independent component for mortality in obese patients and an independent determinant for mortality in diabetes patients. Cardiorespiratory fitness is inversely related to cardiovascular mortality in diabetes and obesity. Low cardiovascular fitness increases CVD mortality in normal weight, overweight, and obese diabetes patients. [10]

Low cardiorespiratory fitness (CRF) is the 4th leading cause for cardiovascular disease and it is important for prognosis of the disease. cardiorespiratory fitness is the ability to transfer O2 to mitochondria to do a prolonged period of physical exercises. CRF depends on ventilation and diffusion of the respiratory system, cardiac function (right and left ventricles function), vascular system, the ability of the muscle to utilize the oxygen from blood and cardiovascular center. CRF is directly related to many physiological systems, it reflects total body health. CRF is expressed as Vo2max that is maximum oxygen consumption.

Cardiorespiratory fitness is the very powerful predictor for risk of mortality (death rate) than other established traditional risk factors like obese, type 2 diabetes mellitus, high blood pressure, dyslipidemia, smoking history, cardiac diseases. Cardiorespiratory fitness helps in the estimation of survival rates; raise in 1 METS causes 10-25% decrease in survival rate. Low levels of cardiorespiratory fitness

are associated with 2-5 folds increase in coronary vascular diseases (CVD) and death rates. Increase in CRF by1-2 METS causes decrease in cardiovascular events and mortality by 10-30%. [11]

The gold standard measure to assess cardiorespiratory fitness is VO2 max (maximal oxygen uptake), expressed as milliliters of O2 uptake per kg of body mass per minute . V̇O2max can be assessed with direct or indirect methods. Direct method provides the most accurate CRF levels done with ventilatory gas analysis by ergometry test. In this study indirect method was used to estimate V̇O 2max by 6-minute walk test [12]

Diabesity patients are at high risk for cardiovascular morbidity and deaths. The combination of type 2 diabetes and obesity causes 5 to 8 times surge in death rates. So, early detection and treatment are important. [13] Most of the studies done on CRF are conducted on western population but there are very limited studies done on assessment of CRF in diabesity patients of Asian Indians which is the major hub for diabetes.

The aim of this study is to compare the cardiorespiratory fitness in Asian Indian men with diabesity and normal healthy subjects. It may be hypothesized that Cardiorespiratory fitness may be lower in diabesity patients compared to normal healthy subjects in Asian Indian men.

MATERIALS AND METHODS

This observational study was conducted in Durgabai Deshmukh College of Physiotherapy, Hyderabad. Total of 30 subjects with Group A - Diabesity patients (n=15) and Group B - Normal healthy subjects (n=15) were recruited in this study. The study was approved by the ethical committee. Height in centimetres and weight in kilograms were measured to calculate the BMI with the standard formula weight in kilograms/height in meter square, waist circumference was measured midway between the lowest ribs and the iliac crest.

Inclusion criteria

Age- 40-50

Only males

Asian Indians

Group A- Diabesity group- Diabetes with HbA1c >6.5%, obesity with BMI>25 kg/m^2, WC >90 centimeters for men. according to WHO Asian specific guidelines. [14]

Group B: Normal healthy individuals (HbA1c <6.5%, BMI <25 kg/m^2, WC <90 centimetres).

Exclusion criteria

HbA1c >11.5%, uncontrolled hype-rtension, musculoskeletal, cardiovascular and respiratory problems, neurological diseases like neuropathy, sensory loss, gestational diabetes, Cognitive impairments, intellectual disability.

The complete assessment was taken and a physical activity readiness questionnaire (PAR- Q) was taken before doing the 6minute walk test. VO2 max was assessed using the 6minute walk test to evaluate cardiorespiratory fitness. The procedure was well explained in detail to all the subjects and informed consent was undertaken who is willing to participate in the assessment. They were not allowed to eat three hours before the test.

The 6-minute walk is simple to perform it is a reliable, highly reproducible and valid tool for assessing the cardiorespiratory fitness in patients. [15]

Six Minute Walk Test (6MWT)

Sixminute walk test was done as per American Thoracic Society (ATS) guidelines. [16] The 6MWT is performed in the corridor with 30 meters flat, hard, long straight surface with free of obstacles. Marking was done every 3 meters in the corridor, with 2 cones at the ends of the 30 meters as a turnaround point. Resting heart rate and the Spo2 measured with pulse oximeter at the beginning of the test. The patients were asked to walk and the stopwatch was started, patients were encouraged to walk as much as possible, patients made to stop the walking, if the patients feel discomfort during the test. After 6 minutes patients were asked to stop the test and Spo2, heart rate, number of laps and distance were measured at the end of

the six minutes. Heart rate was monitored for 2-3 minutes after the test. VO2max is calculated according to the formula
VO2max=Vo2max (ml per kg per min) = 70.161 + (0.023 * 6MWT (meters)) - (0.276 * weight (kilograms)) - (6.79 * sex, where male=0, female=1)) - (0.193 * resting HR (beats per minute)) - (0.191 * age(years)).
Both the groups were assessed the VO2max and compared between the groups.

STATISTICS ANALYSIS

The data was analysed using SPSS software 11.5 version, unpaired t-test was used to check whether differences in means were statistically significant or not.

RESULTS

Table 1 shows the parameters of age, height, weight, BMI, WC, HbA1c and VO2max in both groups. The means values of diabesity and normal healthy subjects for age were 45.7 years and 46.8 years, mean Height were 167.73 and 168.93centimetres, weight were 80.79 and 62.266 kgs, BMI were 28.74 kg/m^2 and 21.760 kg/$m^{2,}$ Waist circumference (WC) were 100.6 and 84.76 centimetres and VO2 max were 21.7400 and 34.2118 ml/kg/minute respectively. Table 2 shows there is significant difference between diabesity and normal healthy subjects in weight, BMI, WC, HbA1C with p- value 0.0001 is less than 0.05. There is a significant decrease in V02max in diabesity patients when compared to normal healthy subjects with t- value is -11.687 with 28 degrees of freedom, mean difference were -12.47180and its p- value 0.0001 is less than 0.05. Graph 1 shows the significant decrease in VO2 max in diabesity patients when compared to normal healthy subjects.

Table 1: Group Statistics for age, height, weight, BMI, WC, HbA1c, V02 max

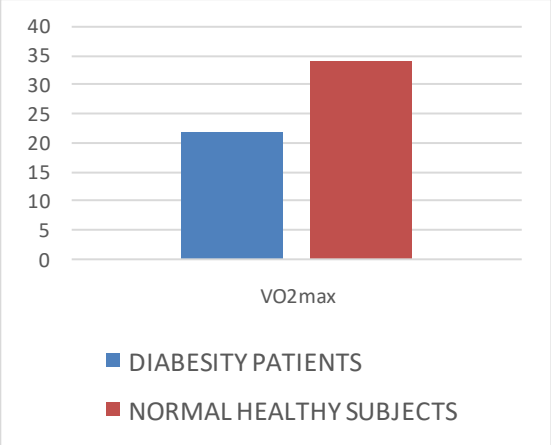
	Group	N	Mean	Std. Deviation	Std. Error Mean
AGE (years)	Diabesity	15	45.7333	2.76371	.71359
	Normal healthy subjects	15	46.8000	2.65115	.68452
Height (cm)	Diabesity	15	167.7333	2.78944	.72023
	Normal healthy subjects	15	168.9333	4.90578	1.26667
Weight (kg)	Diabesity	15	80.7933	5.25282	1.35627
	Normal healthy subjects	15	62.2667	4.06143	1.04866
BMI (kg/m^2)	Diabesity	15	28.7467	2.16725	.55958
	Normal healthy subjects	15	21.7600	.53692	.13863
WC (cm)	Diabesity	15	100.6333	2.45114	.63288
	Normal healthy subjects	15	84.7667	3.98617	1.02922
HbA1c (%)	Diabesity	15	8.5667	.81299	.20991
	Normal healthy subjects	15	5.5933	.49924	.12890
VO2 max (ml per kg per min)	Diabesity	15	21.7400	2.08837	.53922
	Normal healthy subjects	15	34.2118	3.56664	.92090

The table 1 shows the Mean, Std. Deviation, Std. Error means of age, height, weight, BMI, WC, HbA1c and VO2 max in diabesity and normal healthy subjects.

Table 2:Independent Samples Test between diabesity and normal healthy subjects

		t-test for Equality of Means				
		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Weight (kg)	Equal variances assumed	10.807	28	.000	18.52667	1.71440
BMI (kg/$m^{2)}$	Equal variances assumed	12.119	28	.000	6.98667	.57650
WC (cm)	Equal variances assumed	13.132	28	.000	15.86667	1.20824
HbA1c (%)	Equal variances assumed	12.070	28	.000	2.97333	.24633
VO2 max (ml per kg per min)	Equal variances assumed	-11.687	28	.000	-12.47180	1.06715

There is significant difference between diabesity and normal healthy subjects in weight, BMI, WC and HbA1C with p- value 0.0001 is less than 0.05. There is a significant lower in V02max in diabesity patients when compared to normal healthy subjects with t- value is -11.687 with 28 degrees of freedom, and its p- value 0.0001 is less than 0.05



Graph 1: VO2max mean values between diabesity and normal healthy subjects

V02max (ml per kg per min) was significantly lower in diabesity patients when compared to normal healthy subjects.

DISCUSSION

Although CRF is an important health indicator, cardiorespiratory fitness assessment is not usually performed in many clinical settings. In this study, we have assessed the cardiorespiratory fitness in Asian Indian men with diabesity and the results showed that there is a statistically significant decrease in VO2max in group A -Diabesity patients compared to Group B-Normal healthy individuals.

South Asians have unique obesity phenotype with lower cardiorespiratory fitness. The possible reasons are genetic heritability to lower CRF and shown that insulin dysregulation, mitochondrial deficiencies, and lipid oxidation are lower in South Asians. LA Lesser et al states that there is a negative relationship between V02max and abdominal obesity. Increase in CRF is associated with less BMI, WC and abdominal obesity in South Asians. [9] Gill et al stated that South Asians have lower fitness phenotype causing anincrease in the risk of type 2 diabetes and CVD. [17] Ghouri et al concluded that less CRF is observed in South Asian population when compared to Europeans. [18]

Meta-analysis reviews states that obesity increases the death rate by 20% for female and 28% for male. Reduced cardiovascular fitness by one METS increases the death risk by 13%. There is an independent association between obesity and CRF. When comparing fit versus fat, unfit people have double the death risk compared to obese. Obese patients with normal fitness have similar death compared to non-obese fit patients. [19] The mechanism for an inverse relationship with CRF and mortality rate may be fit individual have a highcardioprotective risk profile, less cardiac arrhythmia risk, thrombotic accumulation, increase in endothelial function. C reactive protein andpro-inflammatory markers are less in fit people than unfit people. [11]

The level of cardiorespiratory fitness depends on the cardiovascular, pulmonary system and skeletal musculature system. These systems help to achieve appropriate VO2 max by increasing the cardiac output, minute ventilation, increase in arterial dilation and increase oxygen consumption by the active muscle of skeletal system. Obese patients have alteration of these systems resulting in lower cardiorespiratory fitness as a result of excess BMI. Obese patients have altered cardiopulmonary system leading to increase in left ventricle and atrial dimensions causing left ventricle dysfunction leading to reduced cardiac output, and reduced minute ventilation resulted in rise in respiratory rate to increase the tidal volume. Endothelial dysfunction is observed in obese patients. Skeletal muscle alteration is noticed in obese patients, biomechanical changes such as abnormal gait were also observed. All these factors lead to decrease in VO2 max. [20]

Wilms B et al states that Severe obese with diabetes patients shows reduced cardiorespiratory fitness and no significant difference in pulmonary function when compared to only severe obese without diabetes. The possible mechanisms for reduced CRF are mainly impaired mitochondrial function which reduces skeletal muscle mitochondrial capacity in obese and diabetes leading to low CRF. Cardiac autonomic dysfunction is caused by

diabetic neuropathy. [21] Glycemic control in type 2 diabetes is a predictor for CRF. Poor glycemic control is associated with less CRF the mechanism maybe there is an increased stiffness of aorta leads to reduced compliance of aorta it is very important for modulating coronary circulation reduces myocardial work capacity, therefore CRF is reduced. Poor CRF may be also due to insulin resistance is seen in type 2 diabetes, studies showed that there is a negative correlation between insulin resistance and CRF in diabetes. Endothelial dysfunction may cause reduced CRF. Type 2 diabetes has subclinical left ventricular dysfunction causes reduced cardiac output response to an increase in exercise performance and reduces CRF. [22]

The results are inconsistent with other studies. In type 2 diabetes patients with overweight and obesity is associated with low cardiorespiratory fitness than normal weight adults. The obesity prevalence in diabetes is 60.2% which is double than the general population 32.2%. [23] These finding shows a very strong link between obese and type 2 diabetes mellitus. [24] Paul D. Loprinzi et al states that Adults with obese and diabetes have a high risk for morbidities and death rate. Obese diabetes patients have low cardiorespiratory fitness (mean = 22.0 mL/kg/min) than normal weight people (mean = 39.8 mL/ kg/min. Physical therapists are encouraged to apply evidence-based principles for exercise prescription and physical activity program to help patients with diabetes to regulate their blood glucose control, body composition and improve cardiorespiratory fitness. [25]

Similar results are found by Lubica Cibickovaetal stated that Lower level of cardiorespiratory fitness is proved a very important independent and modified risk factor for morbidity and death rate in obese diabetes patients. In spite of that obese diabetic patients are not routinely assessed for fitness, they found that cardiorespiratory fitness is less in obese diabetes when compared to healthy people.[26]

Swadita Dinakar et al found that there is low CRF in type 2 diabetes patients and it is highly associated with obesity so the risk factors should be considered before exercise prescription. [27] Barun Sharma et al assessed the cardiorespiratory fitness in type 2 diabetes patients and its effect of the adiposity, they concluded that there is a significant reduction in cardiorespiratory fitness (VO2max) in type 2 diabetes over and beyond obesity indices indicates that type 2 diabetes is an independent effect on VO2max. [28]

This study provides that cardiorespiratory fitness was lower in diabesity group. So, CRF should be assessed to prevent cardiovascular diseases and mortality. The limitations of the study are small sample size. Further studies can be done on females, different levels of BMI, large sample size.

CONCLUSION

This study concluded that cardiorespiratory fitness was lower in diabesity patients compared to normal healthy subjects in Asian Indian men. So, clinicians and physiotherapists should include cardiorespiratory fitness as a routine assessment for diabesity patients. Prior evaluation of CRF is important before implementing individualized exercise prescription to reduce diabesity and improve cardiorespiratory fitness in Asian Indian men.

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REFERENCES

1. V. Mohan. Obesity and diabetes in Asian Indians. Endocrine Abstracts (2012) **29** S8.3
2. International Diabetes Federation. IDF Diabetes Atlas, 8th ed.; International Diabetes Federation: Brussels, Belgium, 2017
3. Dr.Hetal Pandya, Dr. J D Lakhani, Dr. N Patel. Obesity is becoming a synonym for diabetes in rural areas of India also - an alarming situation. Int J Biol Med Res. 2011; 2(2): 556-560

4. Fried M, Yumuk V, Oppert JM, Scopinaro N, Torres AJ, Weiner R, Yashkov Y, Frühbeck G; European Association for the Study of Obesity, International Federation for the Surgery of Obesity - European Chapter: Interdisciplinary European guidelines on metabolic and bariatric surgery. Obes Facts. 2013; 6:449–468.
5. Frühbeck G, Toplak H, Woodward E, Yumuk V, Maislos M, Oppert JM; Executive Committee of the European Association for the Study of Obesity: Obesity: the gateway to ill health – an EASO position statement on a rising public health, clinical and scientific challenge in Europe. Obes Facts 2013; 6:117–120.
6. Dyson PA: The therapeutics of lifestyle management on obesity. Diabetes Obes Metab 2010; 12:941–946.
7. Dr. Sunil Gupta. A Real Challenge for a Clinician. JCD JUL-SEP 2014. 1(2);4-16
8. S Gulati1,2 and A Misra1,2, Abdominal obesity and type 2 diabetes in Asian Indians: dietary strategies including edible oils, cooking practices and sugar intake 3European Journal of Clinical Nutrition. 2017. 71, 850–857
9. I.A. Lesser, T J.M. Dick, J.A. Guenette. The association between cardiorespiratory fitness and abdominal adiposity in postmenopausal, physically inactive South Asian women. Preventive Medicine Reports. 2015 2; 783 –787
10. Timothy S. Church, MD, MPH, Ph.D.; Michael J. LaMonte, Ph.D.; Carolyn E. Barlow, MS; Steven N. Blair, PED. Cardiorespiratory Fitness and Body Mass Index as Predictors of Cardiovascular Disease Mortality Among Men with Diabetes. Arch Intern Med. 2005; 165:2114-2120
11. Robert Ross, Steven N. Blair, Ross Arena. Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign A Scientific Statement from the American Heart Association. Circulation. 2016; 134:653–699.
12. RadimJurca, Andrew S. Jackson, Michael J. LaMonte. Assessing Cardiorespiratory Fitness Without Performing Exercise Testing. Am J Prev Med. 2005;29(3), 185-193.
13. Verma R.K., Kaur Bhagyapreet, Mishra Ravi and Himanshu D. Recent Trends of Diabesity and its Non-Clinical Management among Urban Pts. Research Journal of Recent Sciences. 2014, Vol. 4; 261-264.
14. Rajendra Pradeepa, Ranjit Mohan Anjana, Shashank R. Joshi, Anil Bhansali, Mohan Deepa. Prevalence of generalized & abdominal obesity in urban & rural India. the ICMR - INDIAB Study (Phase-I) [ICMR - INDIAB-3] Indian J Med Res. 2015 Aug; 142(2): 139–150.
15. Min Chul Lee' Validity of the 6-minute walk test and step test for evaluation of cardiorespiratory fitness in patients with type 2 diabetes mellitus. J Exerc Nutrition Biochem. 2018, 22(1);49-55.
16. American Thoracic Society. ATS Statement: Guidelines for the Six-Minute Walk Test. Am J Respir Crit Care Med. 2002; 166:111-117.
17. Gill J.M, Celis- Morales, CA. Ghouri N. Physical activity, ethnicity, and cardiometabolic health: does one size fit all? Atherosclerosis. 2014.232(2), 319-333.
18. Ghouri N, Purves, D, Mcconnachie. A, Wilson J. Lower cardiorespiratory fitness contributes to increased insulin resistance and fasting glycemia in middle aged South Asians compared with Europeans men living in UK, Diabetologia, 56(10), 2238-2249.
19. Vaughn W. Barrya, Meghan Baruthb, Michael W. Beetsc, J. Larry Durstinec, JihongLiud, Steven N. Blairc. Fitness vs. Fatness on All-Cause Mortality: a meta-analysis. Progress in cardiovascular diseases 56 (2014) 382 – 390.
20. Ross Arena, Lawrence P. Cahalin. Evaluation of cardiorespiratory fitness and respiratory muscle function in the obese population. Progress in cardiovascular diseases. 2014. 56; 457-464.
21. Wilms B, Ernst B, Thurnheer M, Spengler CM, Type 2 Diabetes is Associated with Lower Cardiorespiratory Fitness Independent of Pulmonary Function in Severe Obesity. Exp Clin Endocrinol Diabetes. 2017 May;125(5):301-306.
22. Zhi you Fang, James Sharman, Johannes B. Prins, Thomas H. Marwick. Determinants of exercise capacity in patients with type 2 diabetes. Diabetes care, 2005, 28:1643–1648.
23. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among

US adults, 1999- 2008. JAMA. 2010; 303(3): 235-241.
24. Hamilton CC, Geil PB, Anderson JW. Management of obesity in diabetes mellitus. Diabetes Educ. 1992;18(5):407-410.
25. Paul D. Loprinzi, PhD;1 Gina Pariser. Cardiorespiratory Fitness Levels and its Correlates Among Adults with Diabetes. Cardiopulmonary Physical Therapy Journal. June 2013. Vol 24(2); 27-34.
26. ĽubicaCibičková, David Karasek, Jiri Lukes. The introduction of simple cardiorespiratory fitness testing in overweight/obese type 2 diabetics: a pilot study. Primary Health Care Research & Development. January 201819(5):1-10. ·
27. SwaditaDinakar, S. Sridevi. A study to find the correlation between six minute walk distance and blood glucose level in diabetic patients. Int J Physiother Res 2015, Vol 3(4):1099-04.
28. HanjabamBarun Sharma, Abha Shrivastava, Yogesh. Cardiorespiratory fitness and heart rate recovery in type II diabetes Males: The effect of adiposity. Indian J Physiol. Pharmacol. 2016 60 (3):260-267.

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