Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i2.4300

COMPARISON OF CARDIORESPIRATORY ENDURANCE AMONG DIABETIC AND NON DIABETIC MALE PATIENTS

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Abstract

Background: Type 2 diabetes, caused by insulin insufficiency, results in cardiovascular disease, loss of cardiorespiratory fitness, and exercise tolerance. Physical activity emerges as a beneficial intervention, improving glycemic control, decreasing insulin resistance, optimizing lipid profiles, reducing blood pressure, and sustaining weight loss.

Objective: The current study is aimed to determine the comparison of cardiorespiratory endurance among diabetic and non-diabetic male patients.

Method: In this study, conducted at a tertiary care hospital in Sindh, male participants, both with and without type 2 diabetes were enrolled. Cardiorespiratory endurance was assessed using the Three-Minute Step Test, which measures how rapidly the exercise-induced heart rate returns to baseline.

Results: In the diabetic patient group, the analysis revealed a statistically significant association between age and cardiorespiratory endurance (p-value=0.001**). In the non-diabetic patient group, no significant correlation was found between age and cardiorespiratory endurance (p-value=0.162**).

Conclusion: The study reveals that a significant number of male diabetic patients have below-average cardiorespiratory fitness, highlighting the need for increased awareness and early referral to cardiac rehabilitation programs.

Keywords: Cardiorespiratory fitness (CRF), Type 2 diabetes, Cardiorespiratory endurance (CRE), Physical activity

INTRODUCTION:

In recent years, there has been a significant increase in the prevalence of diabetes, a chronic condition impacting various tissues and organs. This surge is largely attributed to sedentary lifestyles and a rise in the consumption of unhealthy, processed foods. Multiple studies underscore the connection between diabetes mellitus and lifestyle factors, particularly abdominal obesity. This issue has become more widespread due to the rapid pace of urbanization and a decline in physical activity (1). Abdominal obesity is a significant health concern, with research showing a correlation between the onset and progression of diabetes(2).

Diabetes is prevalent in overweight individuals, leading to increased risk of serious illnesses like cancer, kidney disease, cardiovascular disease, and physical disabilities(3). Research indicates that obesity can contribute to elevated hepatic gluconeogenesis, leading to increased production of triglycerides and the deposition of fat in internal organs. This process can initiate an inflammatory response and disrupt endocrine function(4). Studies suggest a connection between vascular endothelial function and the plasma glucose fluctuation index, as identified through ongoing monitoring of plasma glucose level (5). Diabetes has the potential to induce structural damage to the heart and lungs, resulting in conditions such as ventricular stiffness, myocardial dysfunction, hypertrophy, and fibrosis due to prolonged hyperglycemia. Lung volume and dispersion are identified as distinct risk factors independently associated with diabetes (5). This could start a vicious loop that makes the metabolic abnormalities worse(6). Controlling obesity can help treat diabetes and potentially end this vicious cycle. Type 2 diabetes, caused by insulin insufficiency, results in cardiovascular disease, loss of cardiorespiratory fitness, and exercise intolerance (7).Physical activity can prevent type 2 diabetes, with cardiorespiratory fitness potentially reducing cardiovascular disease risk. Less fit males have higher diabetes mortality risk. Research indicates that exercise training can increase Cardiorespiratory Fitness (CRF) even in middle age, despite the traditional belief that CRF decreases with age (8).

Reduced cardiorespiratory fitness (CRF) in individuals with diabetes poses a heightened risk of mortality. Physical activity emerges as a beneficial intervention, improving glycemic control, decreasing insulin resistance, optimizing lipid profiles, reducing blood pressure, and sustaining weight loss. This study seeks to assess and compare cardiorespiratory endurance between diabetic and non-diabetic individuals, offering clinically valuable insights for precision medicine(9).

Cardiorespiratory endurance measures the heart and lung's ability to supply oxygen to muscles during exercise, while cardiorespiratory fitness is expressed as maximum oxygen consumption, influenced by arteriovenous oxygen differential and cardiac output. The gold standard measure of cardiorespiratory fitness is VO2 max, which represents the maximum amount of oxygen an individual can consume. This metric remains consistent over time and serves as a reliable indicator of aerobic capacity (10). Different types of step tests include Harvard Step Test, Queens College Step Test, Simple Step Test, and a 3-minute step test. (11).

MATERIALS AND METHODS

The study was conducted, over a six-month period, male volunteers with and without type 2 diabetes were included in this study, which was carried out at a tertiary care facility in Sindh. A total of 100 male patients, comprising 50 with diabetes and 50 without, voluntarily took part in the Three-Minute Step Test and each participant provided informed consent. Convenience sampling, a non-probability method, was employed, including male patients aged 40 and above with either new-onset type 2 diabetes or without diabetes. Exclusions comprised individuals with recent heart surgery, type 1 diabetes, intellectual disabilities, and asthma.

Data collection involved the administration of the three-minute step test, utilizing a 12-inch-high bench, a stopwatch, a metronome calibrated to 96 beats per minute, and an assistant. Participants were

instructed to step up and down in sync with the metronome for three minutes. Following the test, seated patients had their pulse manually measured, and the beats per minute were recorded on the rating scale.
Participants were categorized into two groups based on diabetes status: the control group (50) and the new-onset type 2 diabetes group(50).Comparative analysis was conducted on cardiorespiratory endurance indicators and general data.
Cardiorespiratory endurance was assessed using the Three-Minute Step Test, which measures how rapidly the exercise-induced heart rate returns to baseline. The metronome was set to 96 beats per minute, and participants followed its rhythm during the three-minute step test. Pulse readings were taken, and scores were determined using the YMCA criteria for men's cardiorespiratory fitness, categorized into seven grades based on age (12).

STATISTICAL ANALYSIS: Data was analyzed by using SPSS (statistical package for social sciences) version 23. Chi square test was applied. P-value ≤ 0.05 considered as significant.

RESULTS: In the group of patients with diabetes (Table 1), the age range from 40 to 50 years was highest (56%), followed by 51 to 60 years (42%), and the lowest percentage (2%), from 61 to 70 years. Similarly, in the non-diabetic group, the age range from 40 to 50 years was highest (72%), followed by 51 to 60 years (20%), and the lowest percentage (8%), from 61 to 70 years. Table 2 shows the association between steps and pulse rate in diabetic and non-diabetic patients according to mean and standard deviation.
Table 3 displays the cardiorespiratory endurance score of male patients with and without diabetes. Of these, 2 (4.0%) had an excellent score, 1 (2.0%) had a good score, 2 (4.0%) had an above average score, 13 (26.0%) had an average score, 14 (28.0%) had a below average score, 13 (26.0%) had a poor score, and 5 (10.0%) had a very poor score among diabetic patients. Of non-diabetic patients, 6 (12.0%) had excellent scores, 6 (12.0%) had good scores, 9(18.0%) had above-average scores, 12 (24.0%) had average scores, 3 (6.0%) had below-average scores, six (12.0%) had poor scores, and 8 (16.0%) had very-poor scores.
In the diabetic patient group, (Table-4) the analysis revealed a statistically significant association between age and cardiorespiratory endurance (p-value=0.001**). Within the age range of 40-50, most diabetic patients demonstrated average to poor cardiorespiratory endurance, with a considerable number falling below average. In the 51-60 age group, a diverse distribution was observed, showing a mix of cardiorespiratory performance levels. However, in the 61-70 age range, limited data was available, making it challenging to draw definitive conclusions.

In the non-diabetic patient group, no significant correlation was found between age and cardiorespiratory endurance (p-value=0.162**). Across the age categories, the distribution of cardiorespiratory performance varied, with individuals in the 40-50 age range showing a mix of performance levels. The 51-60 age group displayed a broader range of performance, including some individuals with excellent cardiorespiratory endurance. Within the 61-70 age range, there was a more limited dataset, but results indicated a relatively balanced distribution across performance levels.

TABLE-1-DIABETIC MALE PATIENTS

Diabetic Patients		
Age	**Frequency**	**Percentage**
40-50	28	56.0%
51-60	21	42.0%
61-70	1	2.0%
Non-Diabetic Patients		
40-50	36	72.0%
51-60	10	20.0%
61-70	4	8.0%

TABLE-2-ASSOCIATION BETWEEN STEPS AND PULSE RATE

	Diabetic Patients	
	Mean	**Standard Deviation**
STEPS	33.8000	11.61807
PULSE RATE	113.8000	12.78551
	Non-Diabetic Patients	
STEPS	48.2600	14.33251
PULSE RATE	103.4800	20.71797

Table-3-CARDIORESPIRATORY ENDURANCE SCORE

Score	**Frequency**	**Percentage**
Non-Diabetic patients		
EXCELLENT	6	12.0%
GOOD	6	12.0%
ABOVE AVERAGE	9	18.0%
AVERAGE	12	24.0%
BELOW AVERAGE	3	6.0%
POOR	6	12.0%
VERY POOR	8	16.0%
	Diabetic Patients	
EXCELLENT	2	4.0%
GOOD	1	2.0%
ABOVE AVERAGE	2	4.0%
AVERAGE	13	26.0%
BELOW AVERAGE	14	28.0%
POOR	13	26.0%
VERY POOR	5	10.0%

Table-4-CORRELATION OF AGE WITH CARDIORESPIRATORY ENDURANCE IN DIABETIC AND NON-DIABETIC MALES

Diabetic Patients								
Age Group	**Excellent**	**Good**	**Above Average**	**Average**	**Below Average**	**Poor**	**Very Poor**	**P-value**
40-50	1	0	0	12	9	6	0	0.001 **
51-60	1	1	2	1	4	7	5	
61-70	0	0	0	0	1	0	0	
Non-Diabetic Patients								
Age Group	**Excellent**	**Good**	**Above Average**	**Average**	**Below Average**	**Poor**	**Very Poor**	**P-value**
40-50	4	6	4	9	2	5	5	0.162
51-60	0	0	4	3	1	0	2	
61-70	2	0	1	0	0	1	0	

Chi square test was applied.
P-value ≤ 0.05 considered as significant.
**significant at 0.05 level.

DISCUSSION

Type 2 diabetes is the most common chronic metabolic illness worldwide. Insulin resistance brought on by aberrant pancreatic β-cell function or insufficient insulin synthesis result in hyperglycemia, which also makes it more difficult for the body to maintain glucose homeostasis(13). The main characteristics of patients with type 2 diabetes include obesity or a greater proportion of body fat, increased insulin resistance in obese patients, and a connection between insulin resistance and epicardial fat deposition(14). Furthermore, over time, visceral fat alters the anatomy of the heart, leading to diseases such as diabetic cardiomyopathy and raised plasma pressure.

Tests of cardio-respiratory endurance are a crucial clinical tool for assessing cardiorespiratory fitness and forecasting unfavorable cardiovascular events in the future. The current study aimed to explore the association between type 2 diabetes and cardiorespiratory fitness. The findings indicated that, among male patients, higher levels of cardiorespiratory fitness were associated with a reduced incidence of diabetes. Consistent with numerous prior studies, this investigation reinforced the established correlation between type 2 diabetes occurrence and cardiorespiratory fitness(15). The study confirmed that an elevated level of cardiorespiratory fitness is linked to a decreased risk of developing type 2 diabetes.

It is often known that as people age, their cardiorespiratory fitness tends to decrease(16). That being said, middle-aged people can improve their cardiorespiratory fitness by engaging in exercise training(17). A study on randomized controlled studies demonstrated that exercise training contributes to an increase in both absolute and relative cardiorespiratory fitness values(18). Moreover, earlier research studied the association between cardiorespiratory fitness (CRF) and changes in daily physical activities found a direct association between cardiorespiratory fitness and the magnitude of modifications in vigorous physical activity(19).

Past meta-analyses have reported an inverse connection between CRF and type 2 diabetes risk, which is consistent with some of our findings in the general population(20). Low cardiorespiratory fitness and the risk of type 2 diabetes are linked via a number of tenable pathways. One such mechanism is that people with low cardiorespiratory fitness also have high insulin resistance(21).

In our study as we compared data of steps and pulse rates to find out the effect of exercise on cardiopulmonary fitness. It is advised that patients with diabetes mellitus exercise appropriately to enhance their quality of life and aid in their recovery. Adult patients with diabetes mellitus are likely to be less physically fit than healthy adults because they have an increased chance of developing problems from arteriosclerotic heart disease. Indeed, earlier research in this field has shown that individuals with diabetes mellitus have a reduced cardiac capacity compared to healthy individuals(22).

In our study 13 diabetic patients had poor cardiorespiratory endurance scores compared to the non-diabetics in which just 6 had poor scores, these findings are consistent with the other studies (20). A high CRF may be able to reduce the diabetogenic effect. These results clearly demonstrate how critical it is to enhance CRF in clinical practice. Additionally, we saw the noteworthy results that showed an unfavorable relationship between elderly diabetic patients and cardiorespiratory fitness.

Our research revealed that as people age, their cardiorespiratory endurance significantly declines. Similar findings were developed in a study conducted on women, which concluded that the major decline in cardiorespiratory fitness that occurs with age in these populations has a significant impact on chronic disease status, risk of cardiovascular disease, and maximal or peak oxygen uptake (V˛o2max and Vʟo2peak, respectively)(23). CRF is known to decrease with age, nevertheless, genetics and other factors may also have a role. On the other hand, most sedentary individuals will see a rise in their CRF if they follow the commonly recognized minimal guidelines for physical activity(24).

Numerous prior prospective cohort studies have demonstrated a correlation between the occurrence of type 2 diabetes and cardiorespiratory fitness. The current investigation verified the link between a greater CRF due to increased physical activity in type 2 diabetes patients associated to age.(25).

Furthermore, prior longitudinal research investigating the correlation between CRF and alterations in daily physical activities revealed a direct relationship between CRF and the degree of change in strenuous physical activity(26).

CONCLUSION

The study reveals that a significant number of male diabetic patients have below-average cardiorespiratory fitness, highlighting the need for increased awareness and early referral to cardiac rehabilitation programs to improve cardiovascular health and overall well-being in diabetic populations.

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