International Journal of Pharmacy and Pharmaceutical Science

ISSN Print: 2664-7222
ISSN Online: 2664-7230
IJPPS 2022; 4(2): 40-51
www.pharmacyjournal.org
Received: 15-08-2022
Accepted: 16-09-2022

Dr. Pradeep Kumar
Medicine Resident, SMS Medical College and Hospital, Jaipur, Rajasthan, India

Dr. Vishal Gupta
Professor, Department of Medicine, SMS Medical College and Hospital, Jaipur, Rajasthan, India

Dr. Ajeet Singh
Principal Specialist Dept. of Medicine, S.M.S. Hospital Jaipur. Medical Superintendent R.U.H.S, Jaipur, Rajasthan, India

Dr. Suresh Yadav
Senior Medicine Resident, Department of Tropical Medicine, S.M.S. Hospital, Jaipur, Rajasthan, India

Corresponding Author:
Dr. Suresh Yadav
Senior Medicine Resident, Department of Tropical Medicine, S.M.S. Hospital, Jaipur, Rajasthan, India

A study of pulmonary function tests in patients with type 2 diabetes mellitus and their association with glycemic control and duration of diabetes at SMS hospital Jaipur

Dr. Pradeep Kumar, Dr. Vishal Gupta, Dr. Ajeet Singh and Dr. Suresh Yadav

DOI: https://doi.org/10.33545/26647222.2022.v4.i2a.87

Abstract
Introduction: Reduced lung function in diabetes has been described in various researches but its clinical importance is not yet clear. Pulmonary complications of diabetes mellitus (DM) have been poorly studied. Moreover, the duration of DM and glycemic control have varied impact on the pulmonary functions. Thus, we aimed to study the pulmonary function test abnormalities and observe its association with duration of DM and glycosylated hemoglobin.
Aims and Objectives: The study was undertaken to analyze the pulmonary function parameters in diabetic patients and compare it with age and gender matched healthy subjects and correlated forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) in diabetic patients with duration of the disease and glycosylated hemoglobin (HbA1c).
Materials and Methods: Hospital based cross-sectional study in department of Medicine SMS Medical College Jaipur. Pulmonary function tests (PFTs) were recorded in 66 type 2 diabetic patients and 66 normal healthy control.
Results: The mean FVC was significantly lower in Diabetes patients as compared to control subjects. The mean FVC was 74.09±5.56 in Diabetic category whereas mean FVC was 95.45±2.07 in control category. Similarly mean FEV1 was significantly lower in Diabetes patients as compared to control subjects. The mean FEV1 was 77.04±7.60 in Diabetic category whereas mean FEV1 was 88.82±5.30 in control category. There was negative correlation observed between glycemic control and duration of Diabetes with PFT i.e. PFT decreases with increment in HBA1C, or increased duration of DM.
Conclusion: The pulmonary parameters are effected in patients of Diabetes and we should monitor PFT in these patients for better management.

Keywords: Diabetes mellitus, pulmonary function tests (PFTS)

Introduction

Diabetes mellitus is a metabolic disorder with miscellaneous etiologies characterized by chronic hyperglycemia and disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both [1]. It is accompanied by various biochemical, morphological and functional dysfunction and abnormalities which may precipitate complications affecting the renal, cardiovascular, nervous systems and also skin, liver, collagen and elastic fibres. Diabetes mellitus is a multisystem disorder that affects many organs of the body [2].

In contrast to organs like eyes and kidney, lung has not been considered as a seat of target organ damage and hence there is no focus on routine screening procedure like pulmonary function test in diabetic patients. The lungs have extensive micro vascular circulation and abundant connective tissue which makes the lung tissue susceptible to microangiopathy process and non-enzymatic glycosylation of tissue proteins, induced by chronic hyperglycemia, thereby making the lung a "susceptible organ" in diabetic patients [3]. The alveolar capillary network is the largest microvascular organ having surface area about 140 m^2 and it receives the entire cardiac output. The pulmonary reserves are larger therefore, the symptoms and disability from diabetes develop late in lung as compared to other organs.

Therefore pulmonary function abnormalities remain clinically latent and not focused early in diabetic patients [4, 5]. So there should be focus on routine measurement of airflow limitation which may predict morbidity and mortality in patients with diabetes. The present study aimed to study pulmonary function by spirometry in patients with diabetes mellitus and compare the results with non-diabetic healthy controls and to study association of pulmonary function tests in diabetes patients to duration of the disease and HbA1c level.

Materials and Methods

The study was a hospital-based case-control study, done between 1st July, 2021 and 31st December 2022 in the Department of Medicine of SMS Medical College and Hospital. Prior to study the approval from the Institutional Ethics Committee (H) of SMS Medical College and Hospital, Jaipur was taken. Sixty six patients of Diabetes Mellitus were taken. Controls were sixty six non-diabetic apparently healthy individuals with similar characters as cases, regarding age group, sex and with similar exclusion criteria as the study group.

All the cases and controls were given an explanation of the study and informed written consent were taken from them or their attendants before enrollment into the study.

Inclusion criteria

- Diagnosed cases of diabetes mellitus for duration of more than 5 years.
- Exclusion criteria.
- History of smoking.
- Acute or chronic respiratory disease,
- History of occupational exposure affecting lung function,
- Neuromuscular, cardiovascular or end stage kidney disease
- Physical disability that may affect lung function as kyphoscoliosis, pectus excavatum and pectus carinatum.
- Obese persons (BMI more than 30 kg/m2).
- Patients contraindicated for doing spirometry such as recent myocardial infarction, pneumothorax, haemoptysis of unknown origin, recent eye, thorax or abdominal surgery, presence of an acute disease process that might interfere with test performance (e.g. nausea, vomiting)
- Patients who refused to give written informed consent.

Statistical Analysis

The statistical analysis of data was performed using the computer program, Statistical Package for Social Sciences (SPSS for Windows, version 20.0. Chicago, SPSS Inc.) and Microsoft Excel 2010. Results on continuous measurements are presented as mean ± standard deviation are compared using student t test. Discrete data are expressed as number (%) and are analysed using Chi square test. Pearson's correlation coefficient (r) was used to measure the associations among continuous variables. For all analyses, the statistical significance was fixed at 5% level (p value<0.05).

Results

Table 1: Distribution of cases and control according to Gender

Gender	Case		Control		Total		P value
	No.	%	No.	%	No.	%	
Female	21	50.0%	21	50.0%	42	31.8%	1.00
Male	45	50.0%	45	50.0%	90	68.2%	

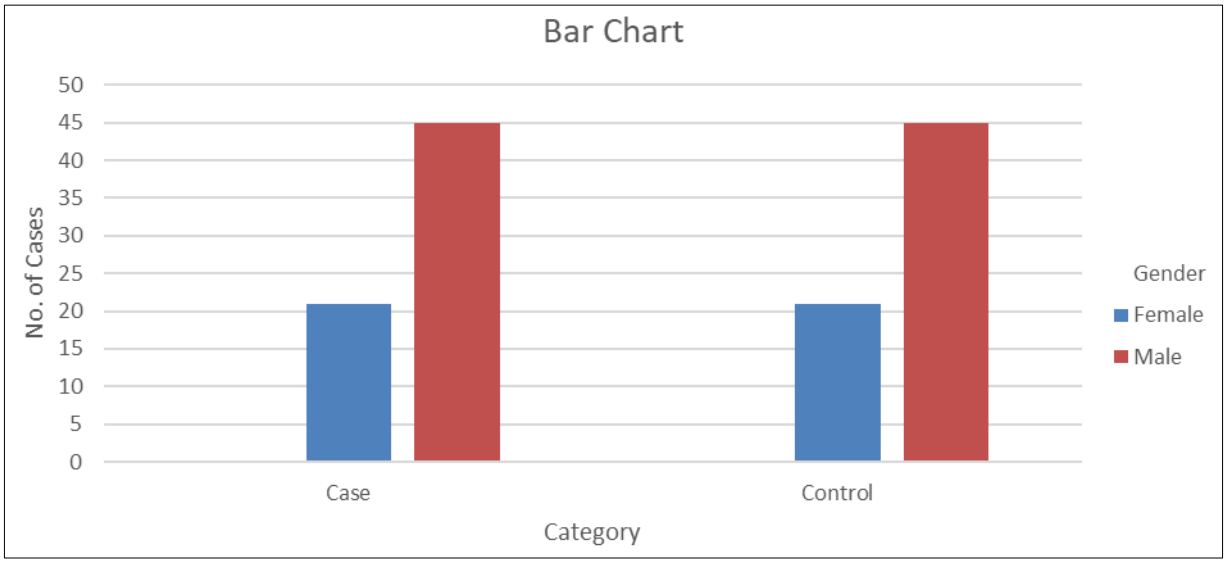

Fig 1: Distribution of cases and control according to Gender.

Table 2: Age distribution of cases and control

Age Groups	Category					
	Case		Control		Total	
	No.	%	No.	%	No.	%
31-40 years	6	37.5%	10	62.5%	16	12.1%
41-50 years	7	31.8%	15	68.2%	22	16.7%
51-60 years	33	53.2%	29	46.8%	62	47.0%
61-70 years	14	70.0%	6	30.0%	20	15.2%
>=71 years	6	50.0%	6	50.0%	12	9.1%
Total	66	50.0%	66	50.0%	132	100.0%

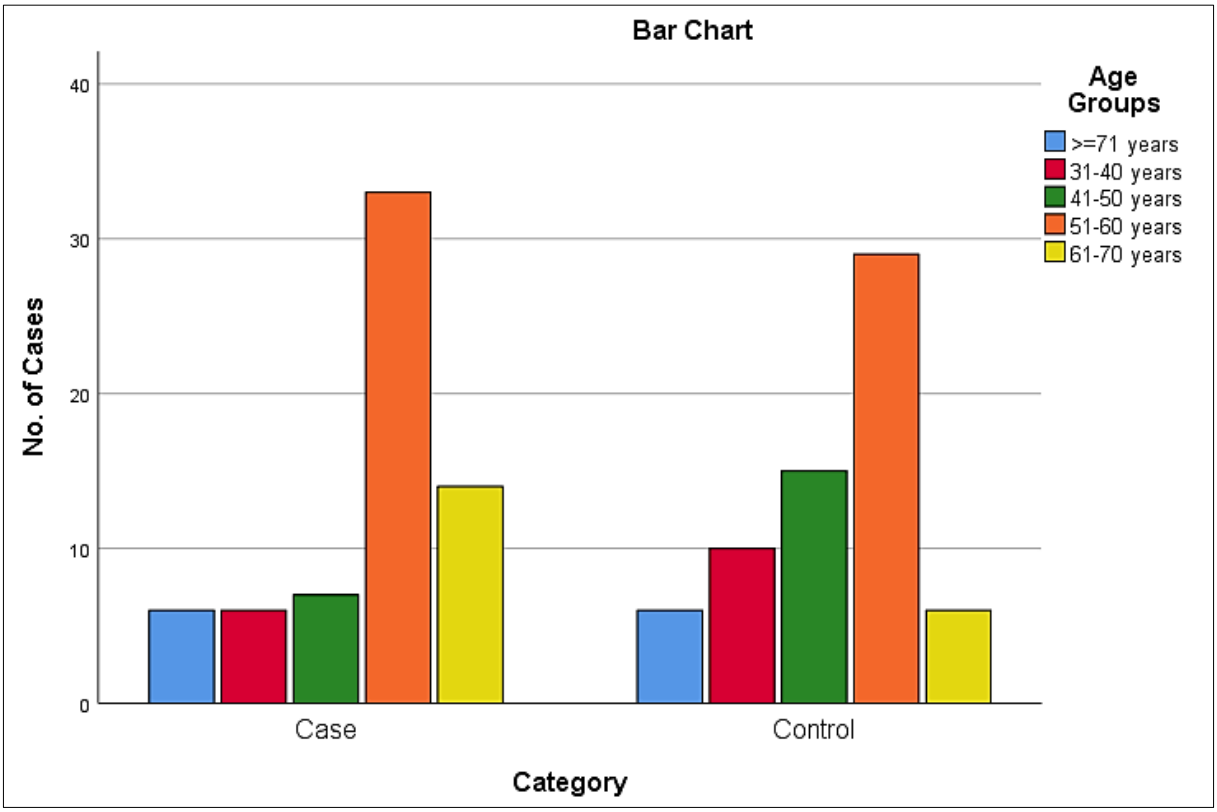

Fig 2: Age distribution of cases and control.

Table 3: Comparison of different parameters between cases and control

Parameters	Category						P Value
	Case		Control		Total		
	Mean	SD	Mean	SD	Mean	SD	
Age	56	9	53	11	55	10	.091
BMI	24.0	3.3	23.9	3.2	23.9	3.2	.880
HBA1C	8.8	1.4	5.5	.2	7.1	1.9	<.001
Duration of DM	8	3	.	.	8	3	
FVC	74.09	5.56	95.45	2.07	84.77	11.51	<.001
FEV1	77.04	7.60	88.82	5.30	82.93	8.81	<.001
FEV1/FVC	113	7	128	123	120	87	.325
PEFR	58.53	5.22	77.58	4.32	68.06	10.69	<.001

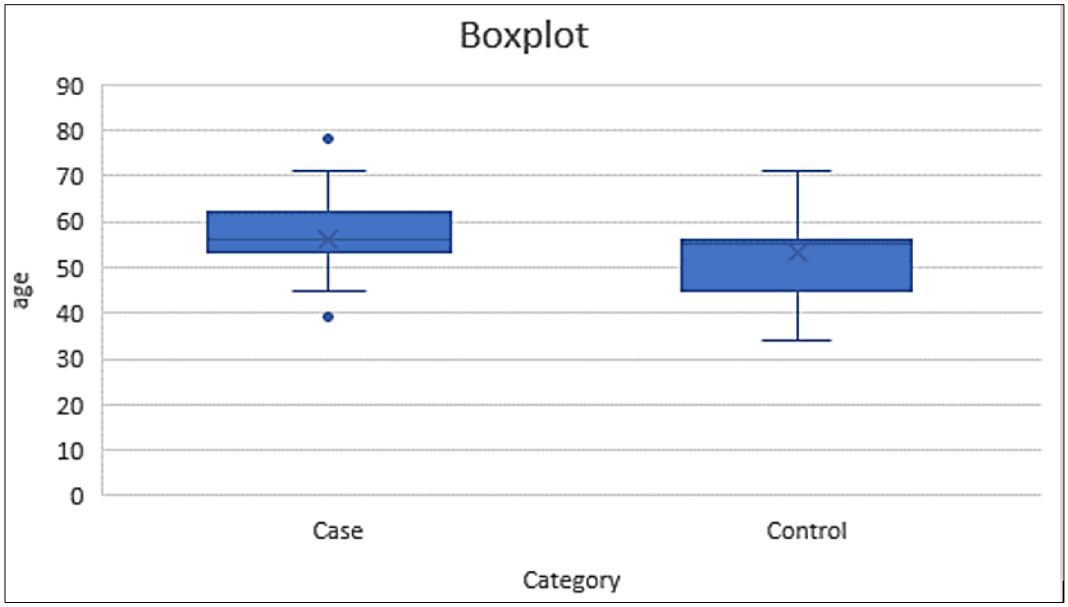

Fig 3: The image is a boxplot comparing the age distributions between two categories, case and control, with both showing similar median ages but varying spreads and potential outliers.

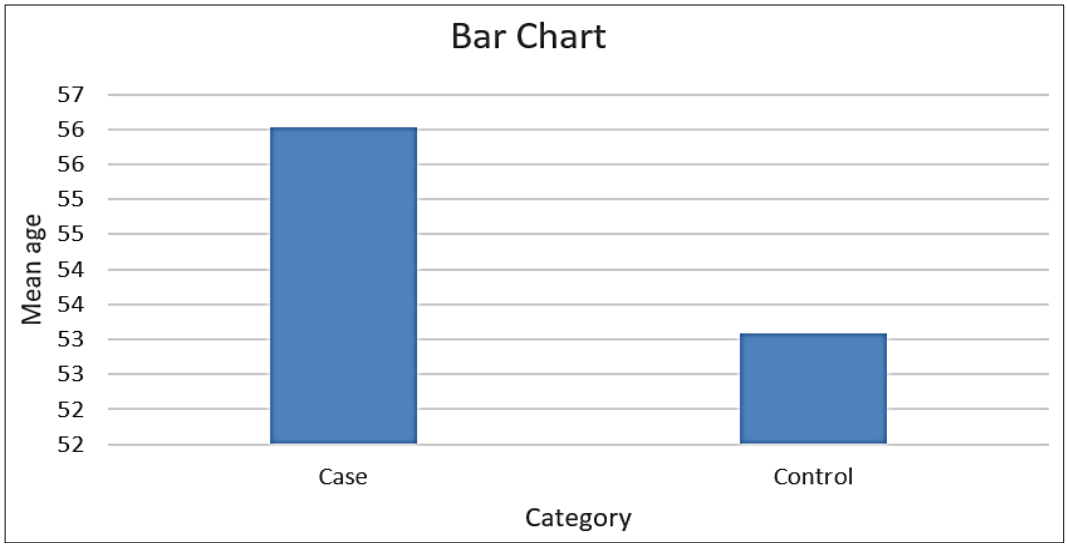

Fig 4: The bar chart shows the mean age for two categories, with 'Case' having a higher mean age than 'Control.

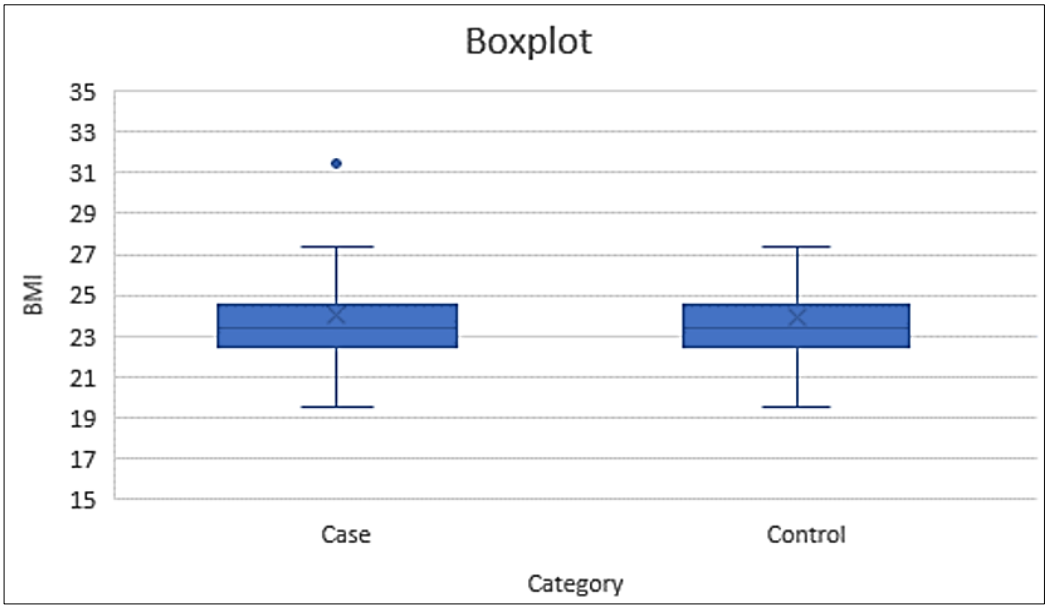

Fig 5: The boxplot compares BMI distributions between 'Case' and 'Control' groups, showing similar medians with a potential outlier in the 'Case' group.

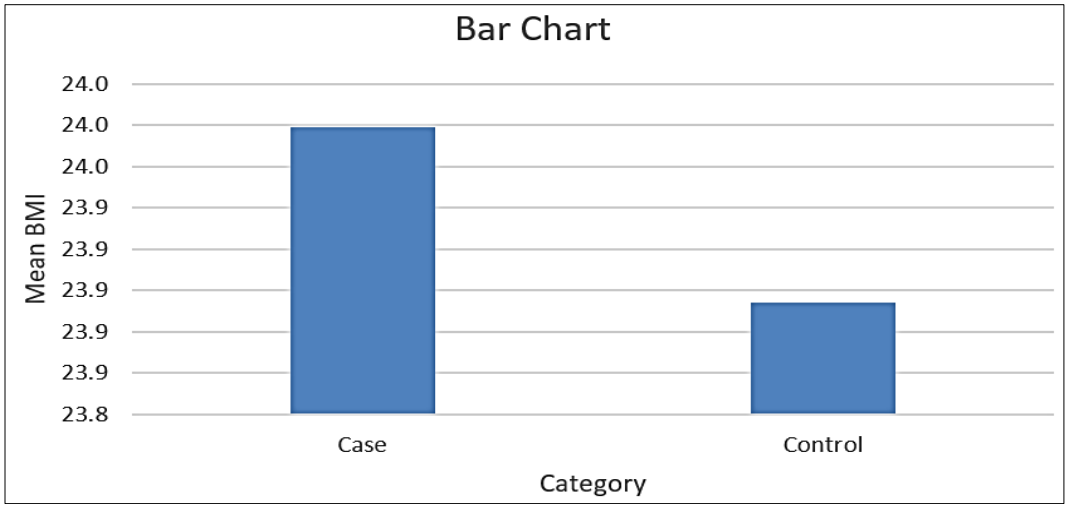

Fig 6: The bar chart displays a higher mean BMI for the 'Case' category compared to the 'Control' category.

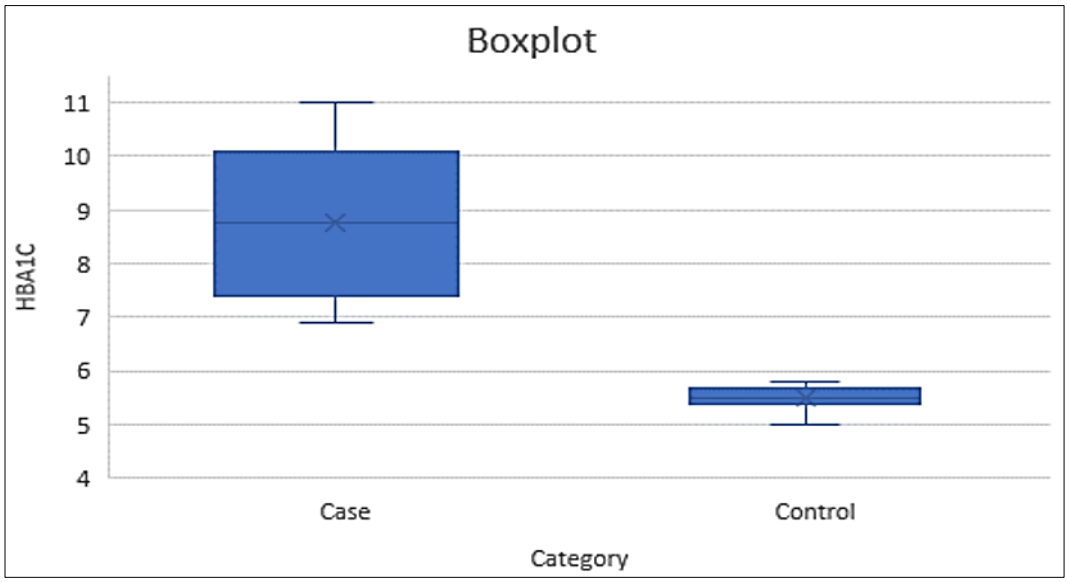

Fig 7: The boxplot illustrates higher HbA1c levels in the 'Case' group compared to the 'Control' group, indicating a broader range of values in the 'Case' category.

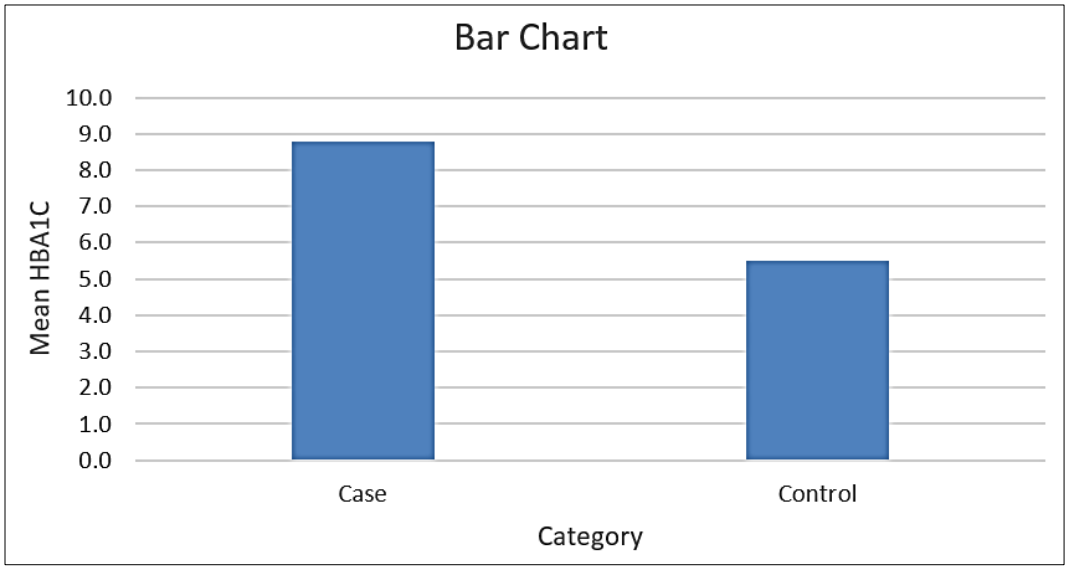

Fig 8: The bar chart shows that the 'Case' group has a higher mean HbA1c level compared to the 'Control' group.

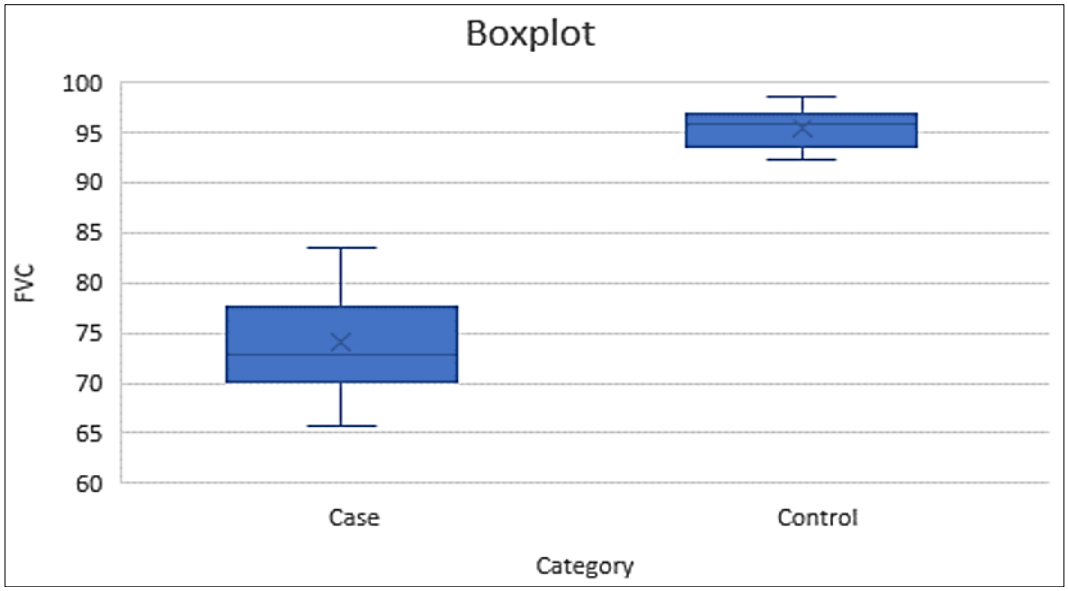

Fig 9: The boxplot compares FVC values, showing a broader range and lower median for the 'Case' group compared to a narrower range and higher median for the 'Control' group.

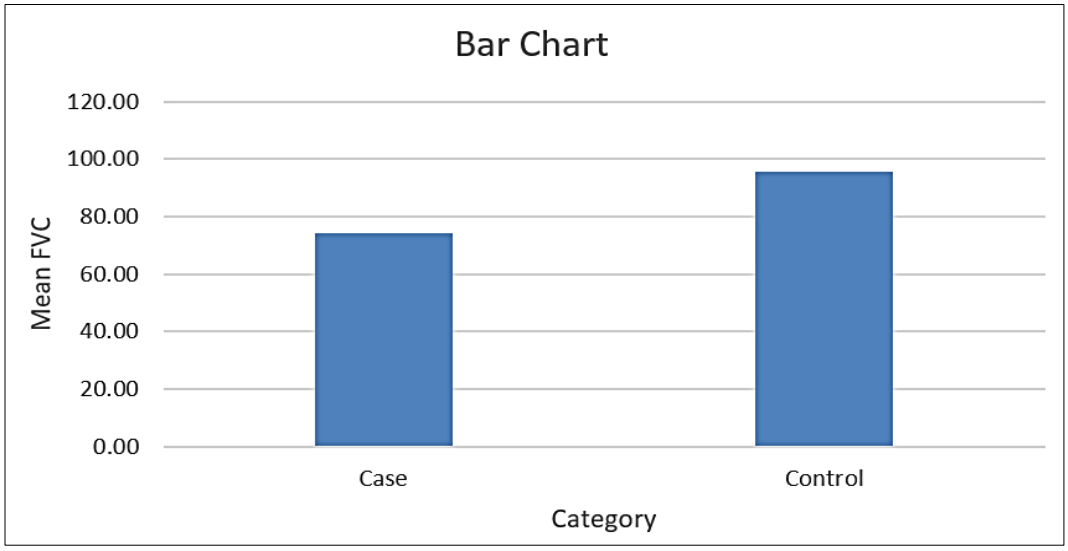

Fig 10: The bar chart shows the 'Control' group with a higher mean FVC (Forced Vital Capacity) compared to the 'Case' group.

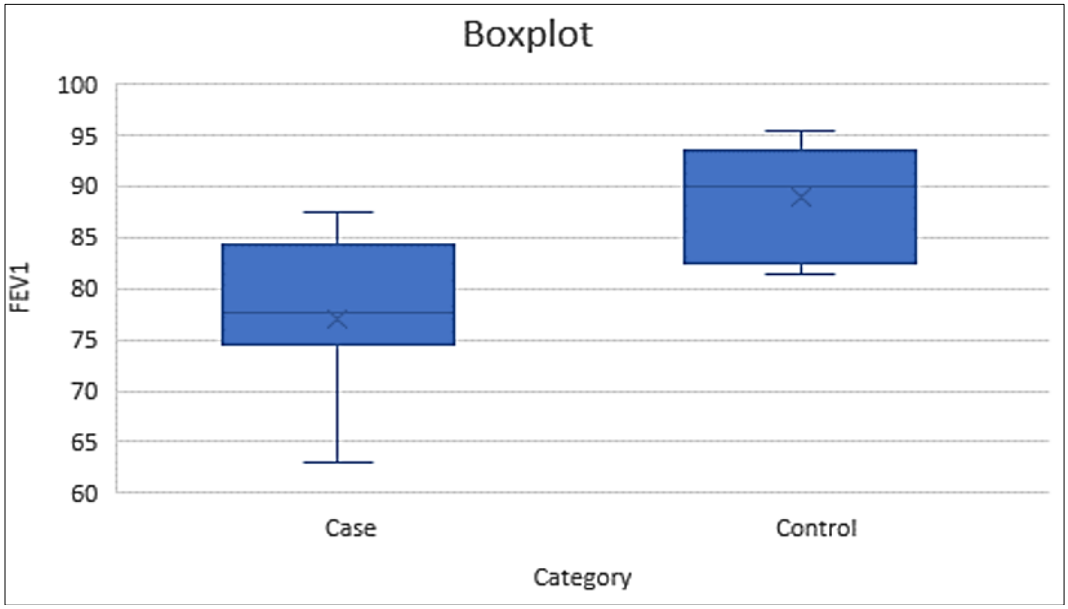

Fig 11: The boxplot illustrates a comparison of FEV1 values, with the 'Case' group showing a wider range and lower median compared to the 'Control' group.

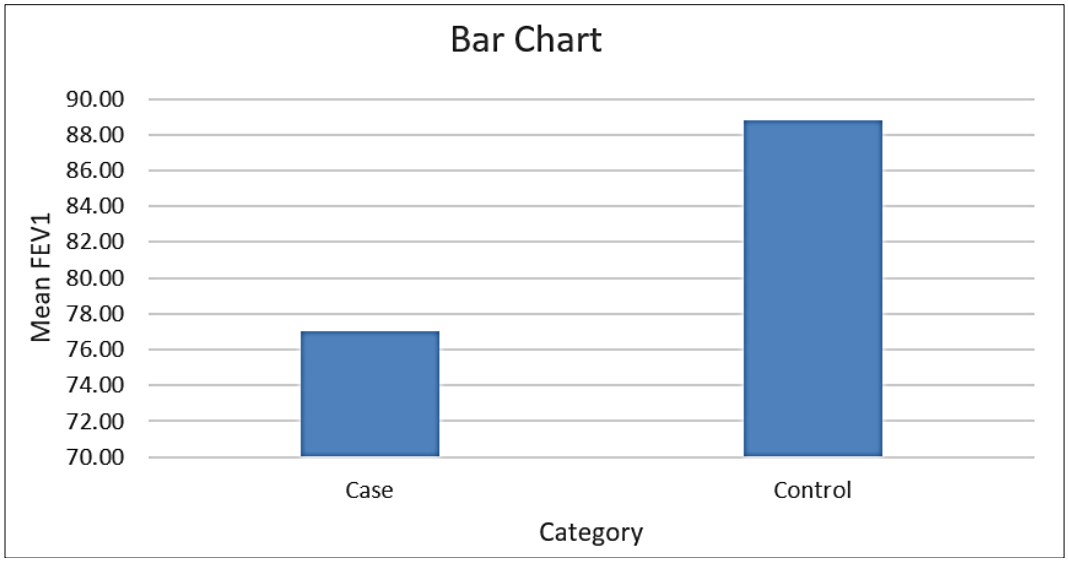

Fig 12: The bar chart shows a significantly higher mean FEV1 value for the 'Control' group compared to the 'Case' group.

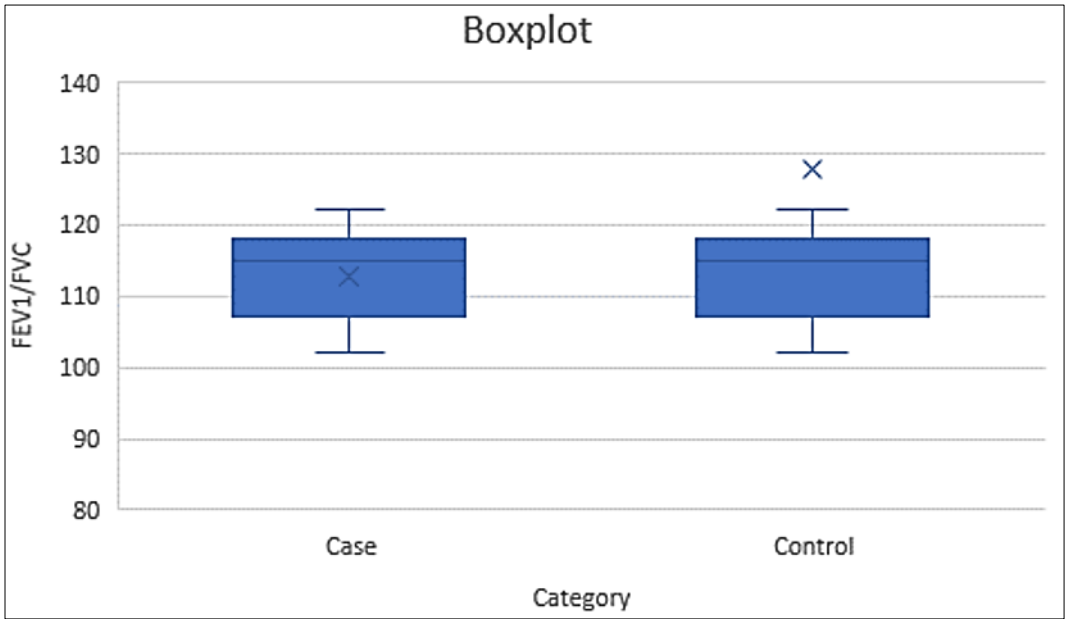

Fig 13: The boxplot displays the FEV1/FVC ratio for both 'Case' and 'Control' groups with similar median values but differing variability and outliers.

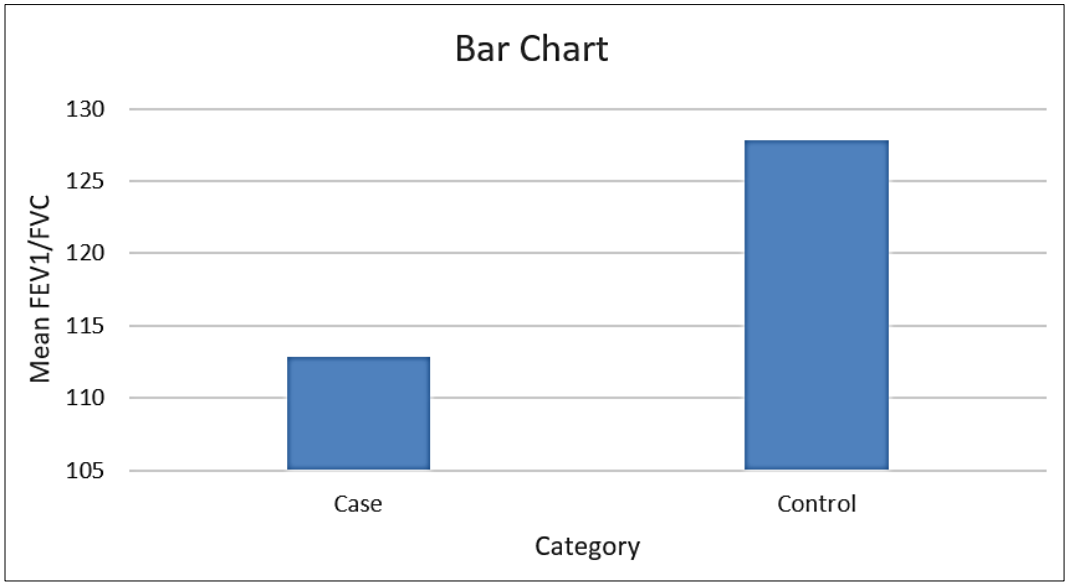

Fig 14: The bar chart shows the 'Control' group with a notably higher mean FEV1/FVC ratio than the 'Case' group.

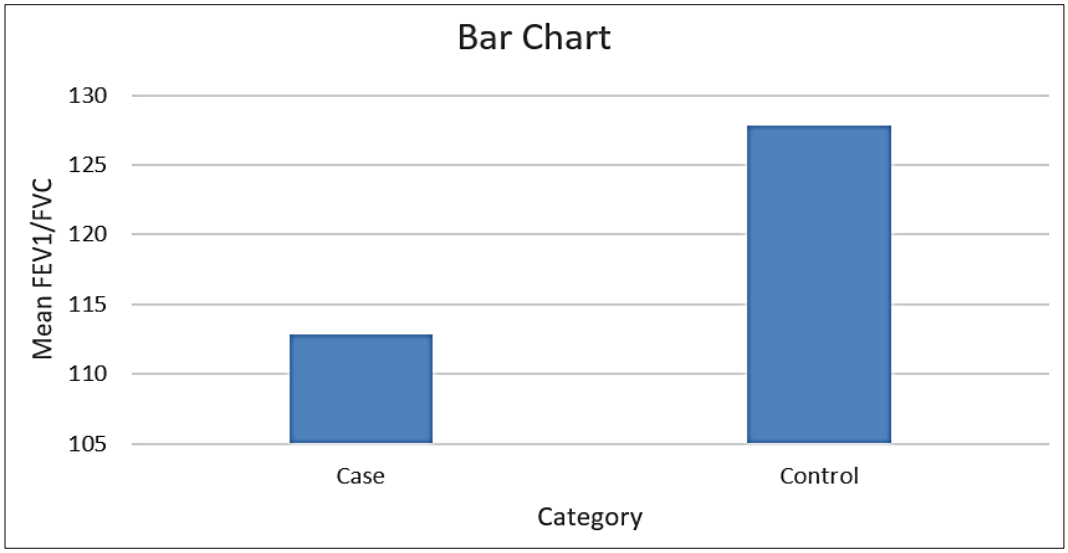

Fig 15: The bar chart compares the mean FEV1/FVC ratio, showing that the 'Control' group has a substantially higher mean ratio than the 'Case' group.

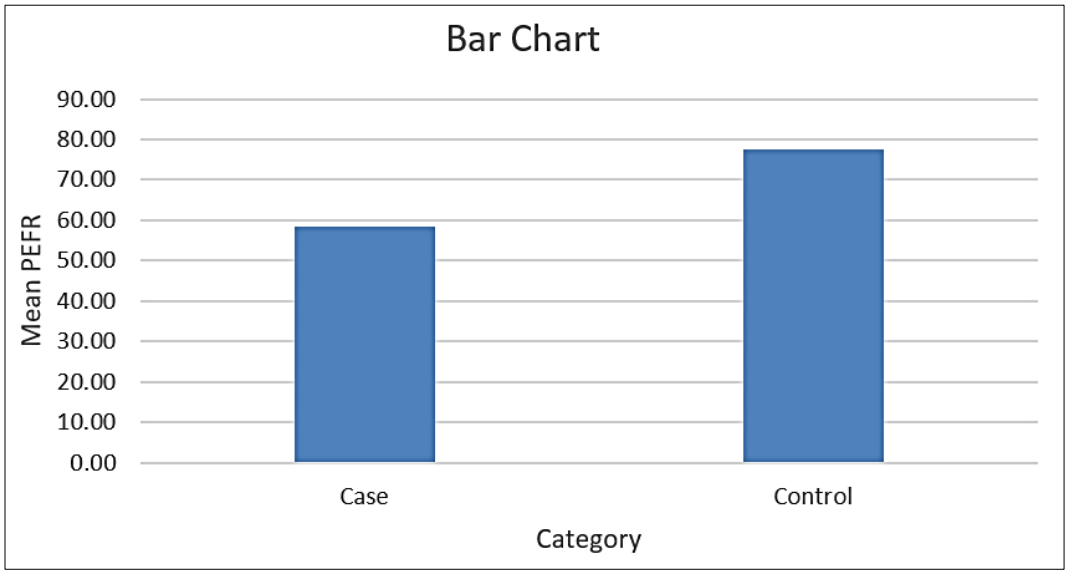

Fig 16: The bar chart shows the 'Control' group with a higher mean PEF (Peak Expiratory Flow) compared to the 'Case' group.

Table 4: Correlation with Duration of DM

Parameter	Correlation coefficient	P Value
FVC	-.718	<.001
FEV1	-.724	<.001
FEV1/FVC	.382	.002
PEFR	-.692	<.001

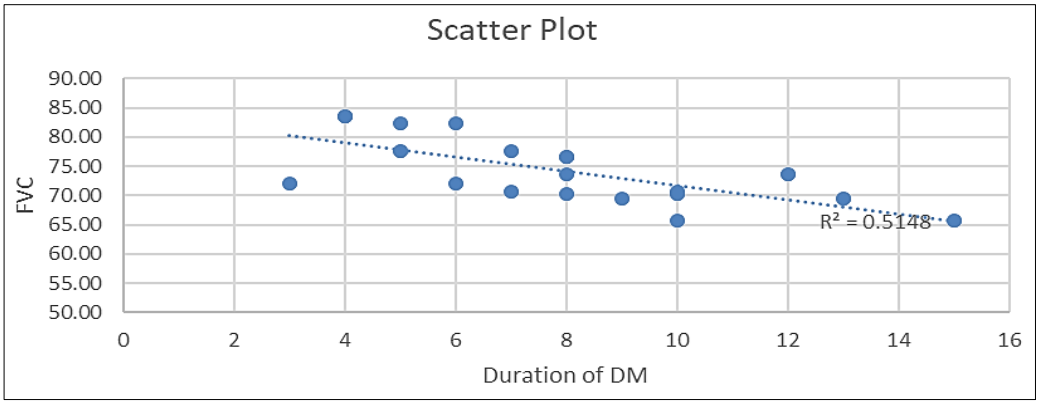

Fig 17: The scatter plot indicates a negative correlation between the duration of diabetes mellitus (DM) and FVC, with an R-squared value of 0.5128.

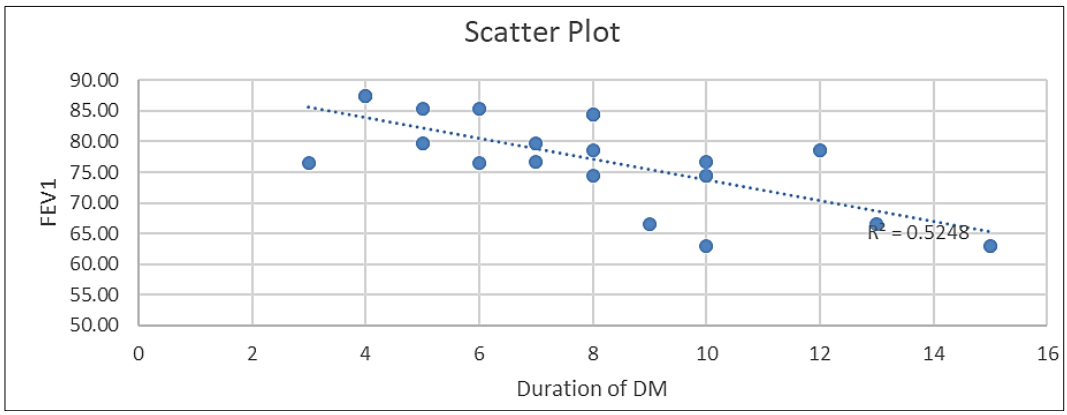

Fig 18: The scatter plot shows a negative correlation between the duration of diabetes mellitus (DM) and FEV1, with an R-squared value of 0.5248.

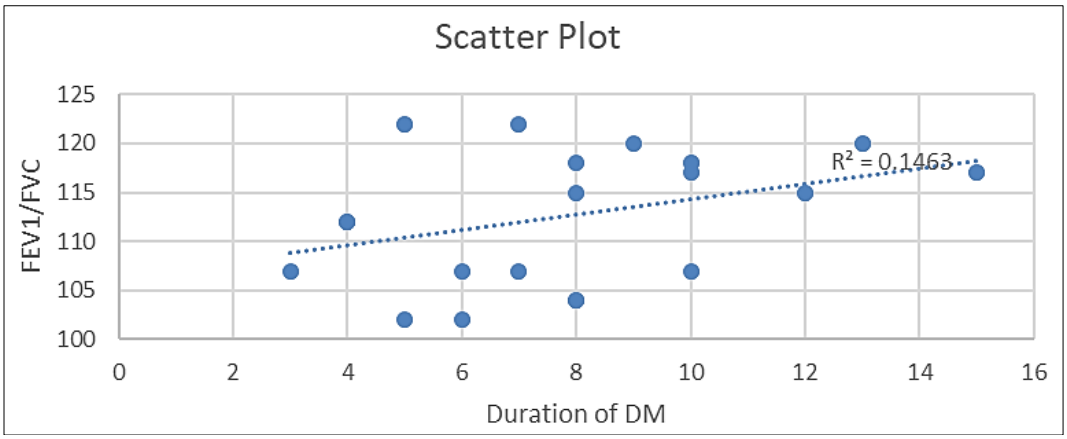

Fig 19: The scatter plot indicates a slight positive correlation between the duration of diabetes mellitus (DM) and the FEV1/FVC ratio, with a low R-squared value of 0.1463.

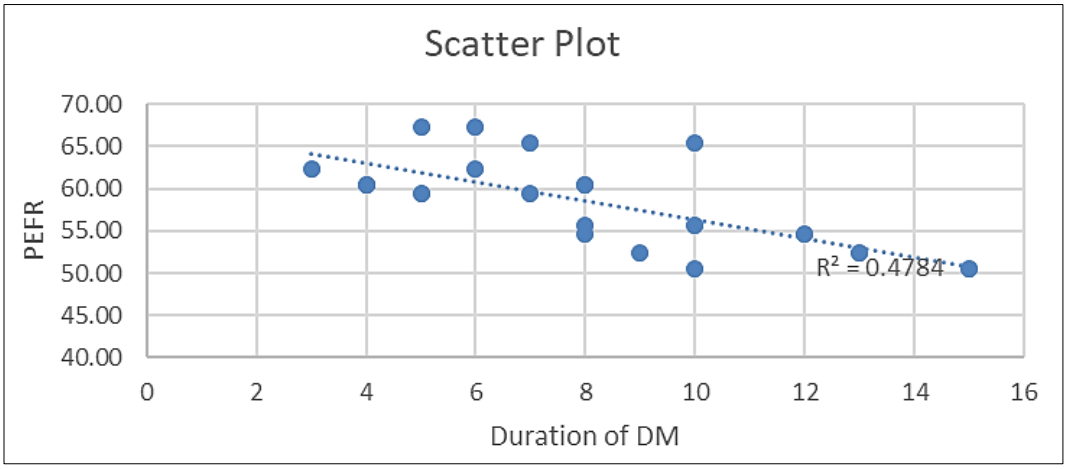

Fig 20: The scatter plot shows a negative correlation between the duration of diabetes mellitus (DM) and PEF (Peak Expiratory Flow), with an R-squared value of 0.4784.

Table 5: Correlation with HBA1C

Parameters	Category			
	Case		Control	
	Correlation coefficient	P Value	Correlation coefficient	P Value
FVC	-.844	<.001	.082	.513
FEV1	-.775	<.001	-.069	.584
FEV1/FVC	.159	.201	.006	.964
PEFR	-.546	<.001	.165	.184

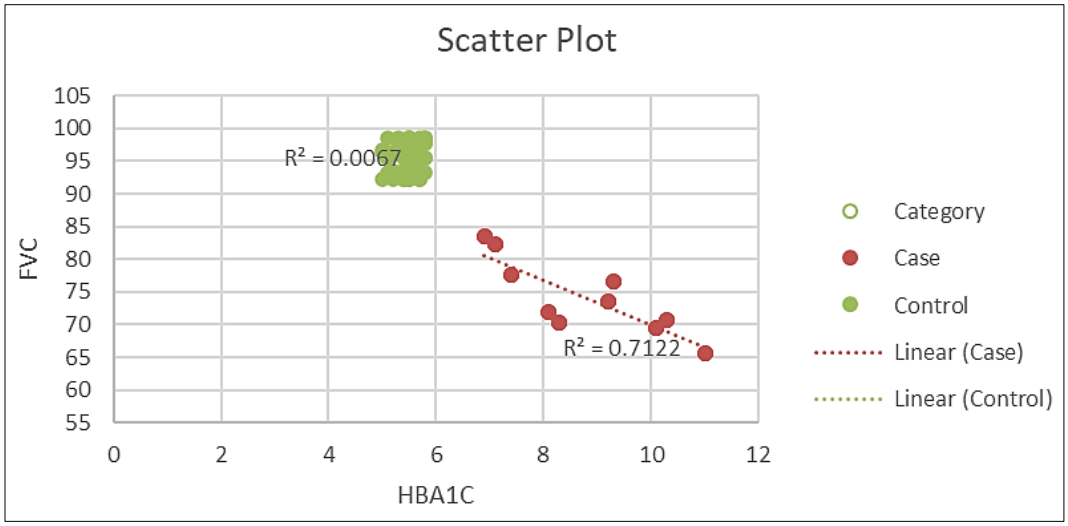

Fig 21: The scatter plot shows two linear trends: a strong negative correlation between HbA1c levels and FVC in the 'Case' category (R^2 = 0.7122), and a negligible correlation in the 'Control' category (R^2 = 0.0067).

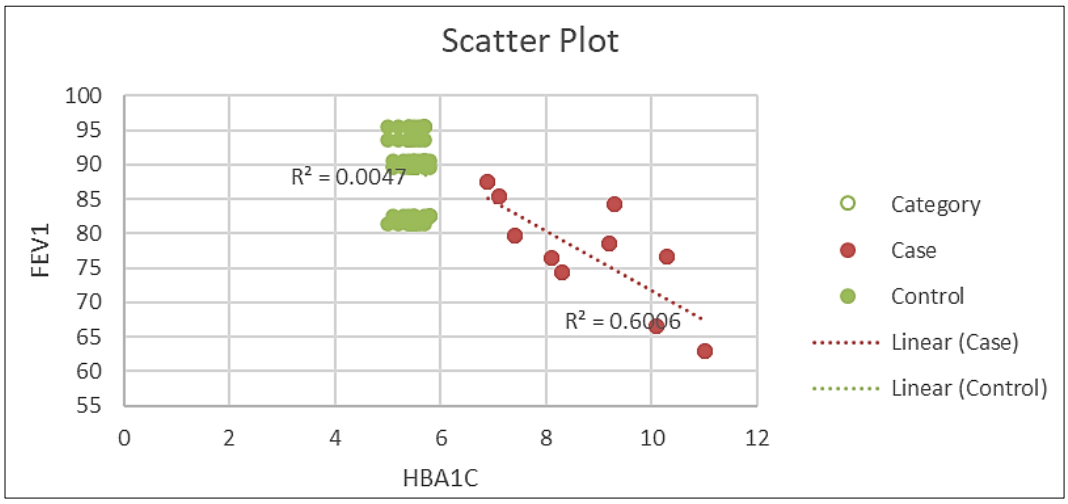

Fig 22: The scatter plot reveals a significant negative correlation between HbA1c levels and FEV1 for the 'Case' group (R^2 = 0.6006) and no meaningful correlation for the 'Control' group (R^2 = 0.0047).

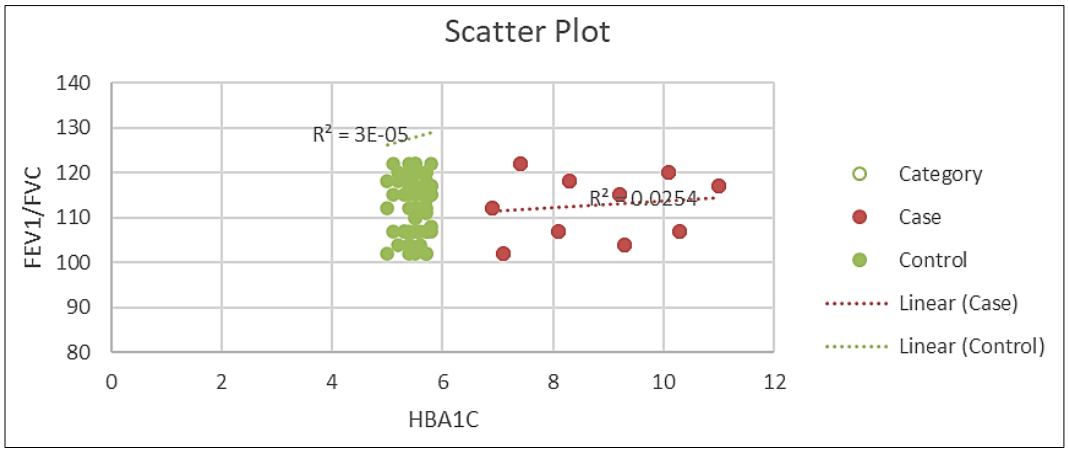

Fig 23: The scatter plot displays a slight positive correlation between HbA1c levels and the FEV1/FVC ratio in the 'Case' group (R^2 = 0.0254) and virtually no correlation in the 'Control' group (R^2 = 3E-05).

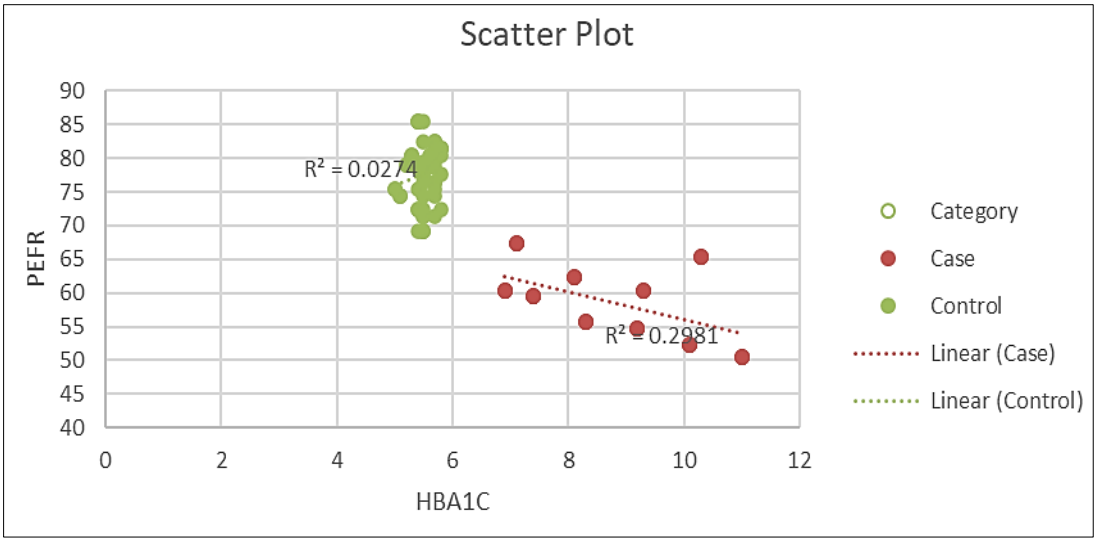

Fig 24: The scatter plot indicates a moderate negative correlation between HbA1c levels and PEF (Peak Expiratory Flow) in the 'Case' group ($R^2 = 0.2981$) and a weak correlation in the 'Control' group ($R^2 = 0.0274$)

Table 6: PFTs profile on the basis of duration of DM

PFTs	Duration of DM				P Value
	<=7 Years		>7 years		
	Mean	SD	Mean	SD	
FVC	78.15	5.02	70.91	3.53	<.001
FEV1	81.75	4.55	73.34	7.51	<.001
FEV1/FVC	111	7	114	6	.056
PEFR	62.51	3.05	55.41	4.38	<.001

Table 7: PFTs profile as per glycemic control categorisation of DM patients

PFTs	HBA1C Group*				P Value
	Good Glycemic Control		Poor Glycemic Control		
	Mean	SD	Mean	SD	
FVC	83.54	.00	72.97	4.75	<.001
FEV1	87.45	.00	75.80	7.08	<.001
FEV1/FVC	112	0	113	7	.419
PEFR	60.43	.00	58.31	5.48	.212

*HBA1C<7 as good glycemic control and >=7 as poor glycemic control

Discussion

PFT and Diabetes

The most striking feature seen in present study was significant association between Diabetes and decreased PFT observed in our study. The mean FVC was significantly lower in Diabetes patients as compared to control subjects. Similarly mean FEV1 was significantly lower in Diabetes patients as compared to control subjects. Similarly mean PEFR was significantly lower in Diabetes patients as compared to control subjects. The mean FEV1/FVC was higher in Diabetes patients as compared to control subjects but it is not statistically significant.

DM Duration and PFT

The other striking feature seen in present study was significant association between Diabetes duration and decreased PFT observed in our study. There was negative correlation observed between DM Duration and PFT i.e. as duration of DM increased PFT decreases.

Discussion

In Diabetes there occurs non-enzymatic glycosylation of proteins in the lungs and chest wall which makes the collagen less susceptible to proteolysis and resulting in accumulation in lung connective tissue. Moreover in diabetic patients non-enzymatically glycosylated collagen appears to be more resistant to digestion by pepsin and collagenase as compared to non-diabetics. Therefore chronic hyperglycemia seen in diabetes causes glycosylation of lung collagen leading to decrease in compliance of lung parenchyma which leads to restrictive changes in lungs.

Conclusion

The pulmonary parameters are deranged in patients of diabetes and therefore PFT should done as screening test in these patients for better management and for delaying the onset of various respiratory complications PFT should be done in patients presenting with diabetes as a routine OPD procedure and moreover there should be proper management of glycemic control in Diabetes as it has significant detrimental effect on PFT.

Conflicts of Interest

No potential competing interest was reported by author (s).

Funding Information

The author (s) received no financial support for the research, authorship, and/or publication of this article.

Acknowledgment
None to declare.

References

1. Definition, Diagnosis and Clasification of Diabetes Mellitus and its Complications. World Health Organization, Department of Non Communicable Disease Surviellance, Geneva. Available from: http://www. WHO_NCD_NCS_99.2.pdf.
2. Kronenberg L, Melmed P. Williams's textbook endocrinology. 10th ed. Elsevier India Publisher.
3. Marvisi M, Bartolini L, del Borrello P, Brianti M, Marani G, Guariglia ACA. Pulmonary function in non-insulin-dependent diabetes mellitus. Respiration. 2001;68:268-272
4. Goldman MD. Lung dysfunction in diabetes. Diabetes Care. 2003;26(6):1915-1918.
5. Hsia CC, Raskin P. Lung function changes related to diabetes mellitus. Diabetes Technol. Ther. 2007;9(1):S73-S82.
6. Leahy TL, Clark NG, Cefalu WT, editor. Medical management of diabetes mellitus. CRC Press; c2000 Feb 17.
7. Nathan DM, Genuth S, Lachin J, Cleary P, Crofford O, Davis M, *et al*. Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus, N Eng. J Med. 1993;329:977-986.
8. Sreeja CK, Samuel E, Kesava Chandra CSS. Pulmonary function in patients with diabetes mellitus. IJPP. 2003;47:87-93.
9. Irfan M, Jabbar A, Haque AS, Awan S, Hussain SF. Pulmonary functions in patients with diabetes mellitus. 2011;28:89-92.
10. Kumar MAS. Diabetes in Elderly: Pulmonary Complication in Elderly Diabetics. Bangalore Micro Labs Ltd; c2005. p. 119-125.
11. Borst BB, Gosker HR, Zeegers MP SA. Pulmonary function in Diabetes: A Metaanalysis. Chest. 2010;138:393-406.