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ORIGINAL RESEARCH ARTICLE

Impact of Diabetes on Ventilatory Function in Asthmatics: A Multicenter Cross-Sectional Study

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Abstract

Introduction: Diabetes mellitus could influence lung function in asthmatic patients, but the data remain conflicting. A better understanding of this interaction is needed to optimize care. The objective of our work is to evaluate the impact of diabetes on the ventilatory function of asthmatic subjects

Patients and method: This is a multicenter cross-sectional study with an etiological focus. The collection of information on asthma patients was done prospectively from 01/04/2020 to 31/12/2023.

Spirometry was performed according to ATS/ERS recommendations. Statistical analyses used binary linear and logistic regression models.

Results: A population of 221 asthmatic patients was collected with a sex ratio of 0.27. The average age of our population is 48.9 ± 15.3 years. Diabetics account for 18.6% of cases. Several conventional and non-conventional spirometric indices are reduced in diabetic asthmatics. FEV1 less than 80% of the predicted value is observed with a significant negative linear correlation between FEV1 levels and glycemic counts. FVC less than 80% of the predicted value is found in 68.3% of diabetics with a significant negative correlation between glycemic figures and FVC values.

Multivariate analysis by binary logistic regression showed that hyperglycemia multiplies the risk of deterioration of FVC by 2.2 times.

Other spirometric parameters such as maximum expiratory flow rates (DEM25-75, DEM50, DEM75, DEP), VEM3 and VEM6 are reduced to different proportions. The risk of a reduced FEV1/MEV3 ratio is multiplied by 2.4 in diabetics.

Conclusion: This research has led to a better understanding of the relationship between diabetes and ventilatory function parameters in adult asthmatic patients. Our results indicate a significant impairment of ventilatory function in the presence of diabetes, which could justify routine screening of lung function in these patients.

Keywords

Diabetes, Bronchial asthma, Ventilatory function, Spirometric indices

Introduction

Asthma is a diverse disease that can be caused by various underlying disease processes. "Asthma phenotypes" are identifiable clusters of randomized demographic, clinical, and/or pathophysiological characteristics [1-3].

Several clinical parameters of asthma, such as lung function and exacerbations, demonstrate a strong association between this disease and diabetes and support that diabetes contributes to worsening asthma outcomes. Many mechanisms underlying these observed associations and their representative biomarkers have been proposed.

The state of systemic inflammation of the metabolic factor diabetes can explain the onset and severity of asthma. This is a relatively unexplored area that can create new scenarios for the strategic approach

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and diagnostic algorithm, with further assessment of the disease. However, prospective studies on this association of diabetes and asthma are limited.

We conducted a multicenter cross-sectional study with analytical aims to evaluate the impact of diabetes on spirometric parameters (FEV1, FVC, Tiffeneau ratio) in a population of adult asthmatics.

Materials and Methods

The population of our study is based on a total of 221 asthmatic patients meeting the inclusion criteria thus defined; it was collected from the pulmonology department of the EHU of Oran, the pulmonology department of the EPH 240 beds of Béchar and the EPSP Debdaba (Béchar), EPSP of the blue zone Béchar, EPSP Ghoualem Oran, USTO EPSP during the period studied (2020-2023).

Spirometry was performed according to ATS/ERS recommendations. Statistical analyses used binary linear and logistic regression models.

Results

Out of a total of 221 participants in the study, 153 (69.2%) were over the age of 39, including 174 women (78.7%) and 47 men (21.3%). All patients were asthmatic.

The 30 and 59 age group accounts for 62.5% of asthma patients collected.

The mean age of men (43.1 ± 14.3 years) is significantly lower than that of women (50.4 ± 15.2 years) with a statistically significant difference (p= 0.003).

The youngest subject is 19 years old and the oldest is 84 years old.

More than two-thirds of the study population (67.9%) are married compared to 20.4% single and 5.4% of our cases are widows (all women)

The notion of allergy was found in 95.5%, dominated by allergic rhinitis in 94% of cases (n = 208). Eighty-five cases (38.5%) of asthmatics are on inhaled corticosteroid therapy alone. All cases take short-acting salbutamol on demand. Only 3.6% of cases are on inhaled corticosteroid therapy combined with high-dose β2 mimetic.

Diabetics represent 18.6% of our study population.

Diabetes and FEV1

34.1% of diabetic subjects have FEV1 rates ≥ 80% (%predicted value) while almost two-thirds of subjects have FEV1 < 80% values (Table 1).

The risk of decreasing FEV1 to less than 80% is multiplied by 2.1 in diabetes.

More than 50% (59.4%) of the diabetic population has FEV1 rates below the LLN compared to the non-diabetic population (Figure 1 and Figure 2).

Table 1: Diabetes and FEV1.

Diabetes	Theoretical FEV1				FEV1 vs LLN				LIN < FEV1 < 80			
	< 80%		≥ 80%		VEMS<LLN		WEMS ≥ LLN				Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	27	65.9	14	34.1	21	51.2	20	48.8	7	17.1	41	100.0
No	85	47.2	95	52.8	73	40.6	107	59.4	12	6.7	180	100.0
Total	112	50.7	109	49.3	94	42.5	127	57.5	19	8.6	221	100.0
P	0.031				0.213				0.066			
OR[IC95%]	2.1[1.1-4.4]				-				-			

Table 2: FVC and Diabetes.

Diabetes	Theoretical FVC				FVC vs LLN				LLN < FVC < 80			
	< 80%		≥ 80%		FVC < LLN		FVC ≥ LLN				Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	28	68.3	13	31.7	19	46.3	22	53.7	9	22.0	41	100.0
No	87	48.3	93	51.7	67	37.2	113	62.8	20	11.1	180	100.0
Total	115	52.0	106	48.0	86	38.9	135	61.1	29	13.1	221	100.0
P	0.021				0.280				0.064			
OR [IC95%]	2.3 [1.1-4.7]				-				-			

Table 3: Distribution of cases by diabetes and the tiffeneau report.

Diabetes	Tiffeneau				Tiffeneau vs LLN				LLN < Tiffeneau < 70			
	≥ 70%		< 70%		Tiffeneau ≥ LLN		Tiffeneau < LLN				Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	31	75.6	10	24.4	33	80.5	8	19.5	2	4.9	41	100.0
No	158	87.8	22	12.2	158	87.8	22	12.2	3	4.9	180	100.0
Total	189	85.5	32	14.5	191	86.4	30	13.6	5	2.3	221	100.0
P	0.046				0.219				0.212			
OR [IC95%]	2.3 [1.1-5.4]				-				-			

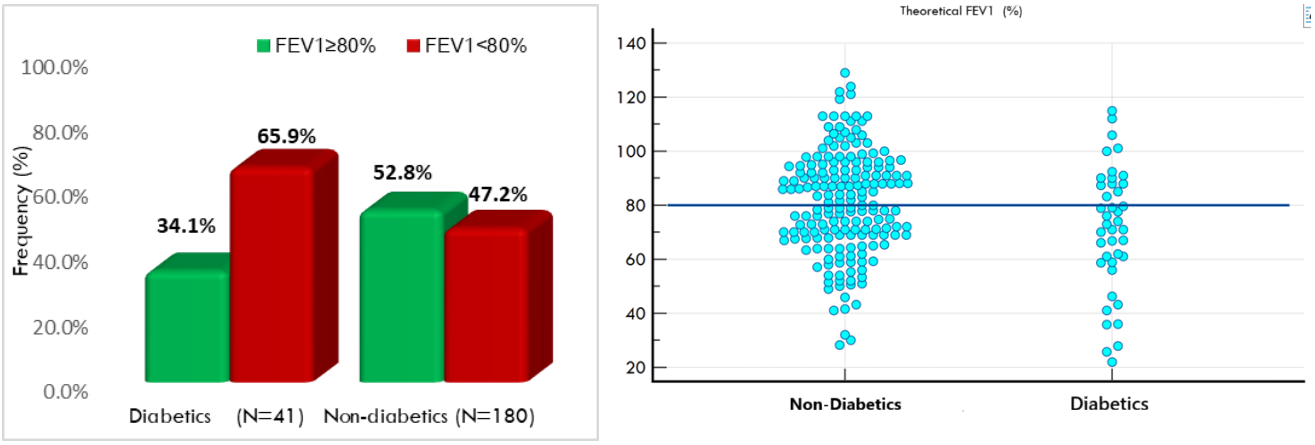

Figure 1: Distribution of asthmatic cases according to theoretical FEV1 and diabetes

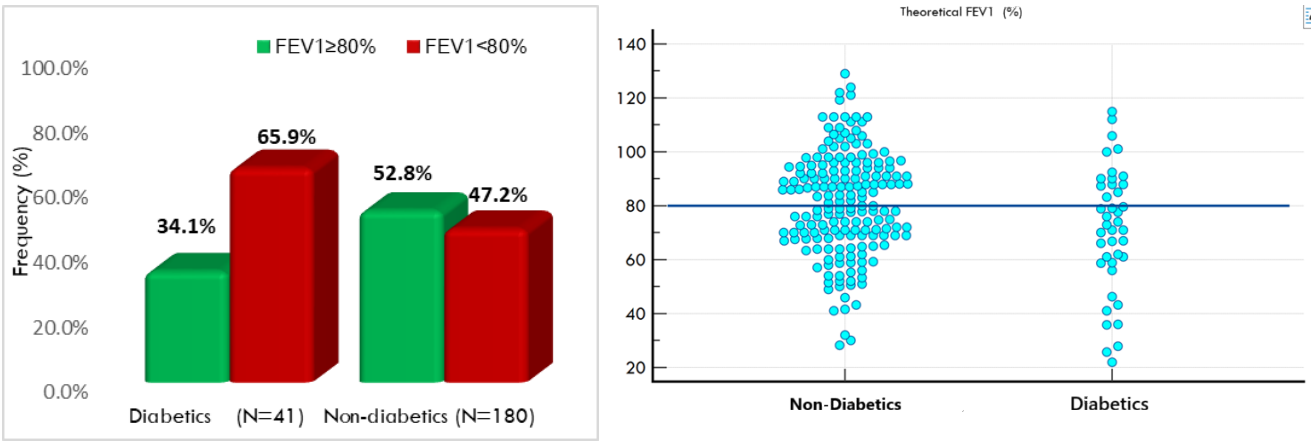

Figure 2: Distribution of asthmatic cases according to FEV1 vs. LLN and Diabetes.

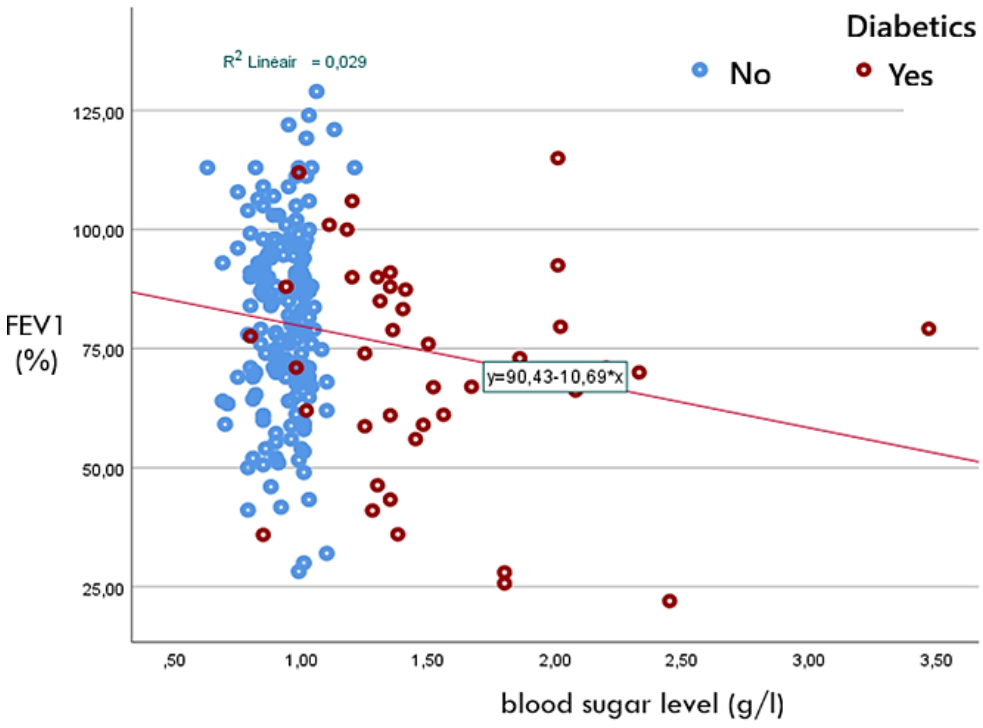

Figure 3: Scatter plot of theoretical FEV1 and asthma blood glucose levels by diabetes.

There is a significant negative linear correlation between FEV1 levels and glycemic counts, the higher the glycemic count, the FEV1 rate decreases according to the formula: FEV1 (%) = 90.43 - 10.69*glycemia (g/L) (Figure 3).

FVC and diabetes

More than two-thirds of diabetic asthmatics (68.3%) have low FVC rates <80% (/predicted) compared to 48.3% for non-diabetics with a significant P of 0.02 (Table 2).

Almost half of diabetic cases have FVC levels below LLN (Figure 4 and Figure 5).

There is a significant negative correlation between glycemic figures and FVC values according to the formula FVC% = 85.71-7.96*glycemia. As the glycemic numbers increase, the FVC values decrease (Figure 6).

Tiffeneau and diabetes

Table 3.

Non-diabetic patients have more cases with Tiffeneau ≥ 70% (87.8% of cases) compared to 75.6% of cases for the diabetic population (Figure 7 and Figure 8).

More cases of diabetic patients have a Tiffeneau below the LLN (19.5%) compared to subjects without diabetes 12.2%.

There is a weak negative correlation between the Tiffeneau ratio and the glycemic figures, as the blood glucose values increase, the Tiffeneau ratio decreases (Figure 9).

Multivariate analysis by binary logistic regression showed that hyperglycemia multiplies the risk of deterioration of FVC by 2.2 times.

Discussion

This study aimed to assess the distribution and association of diabetes in patients diagnosed with asthma. It was possible to determine the relationship between the spirometric indices of asthmatics and diabetes. Thanks to this study, the relationship between diabetes, hyperglycemia and the various conventional spirometric parameters has been elucidated.

The study also looked at a more diverse population that includes people from all walks of life.

In our study, the majority of diabetic asthmatics (65.9%) experienced low rates of FEV1, which represents

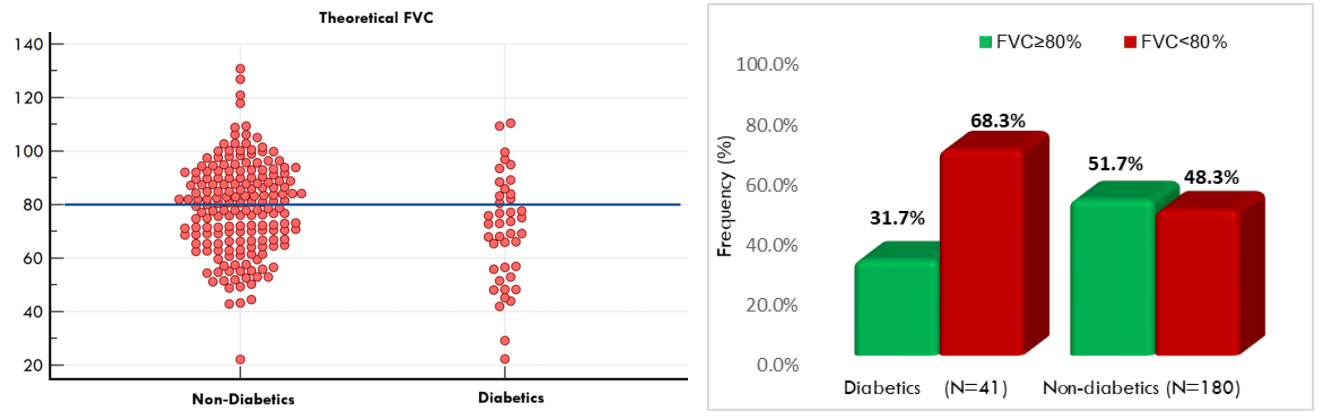

Figure 4: Distribution of asthmatic cases according to theoretical FVC and diabetes.

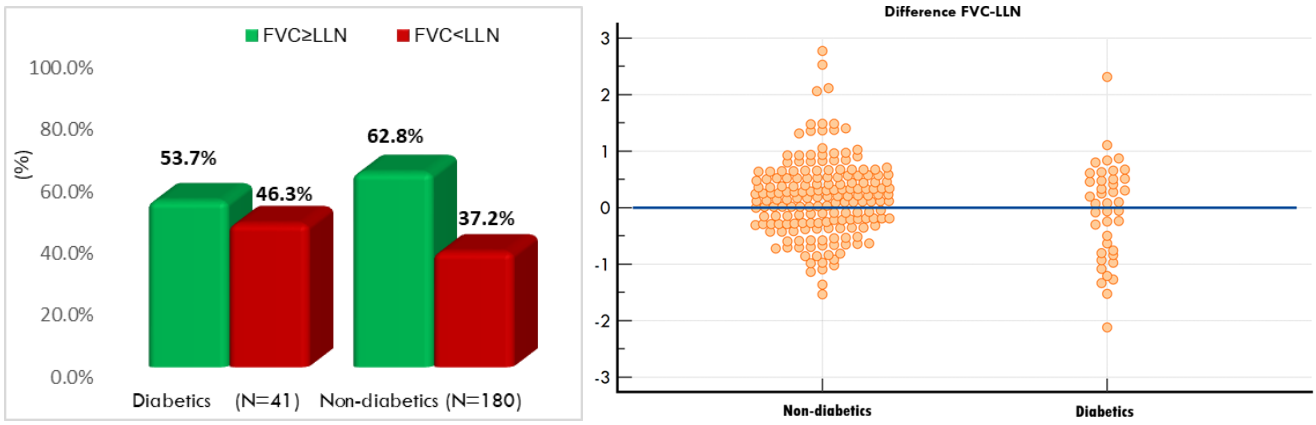

Figure 5: Distribution of asthmatic cases according to FVC vs. LLN and diabetes.

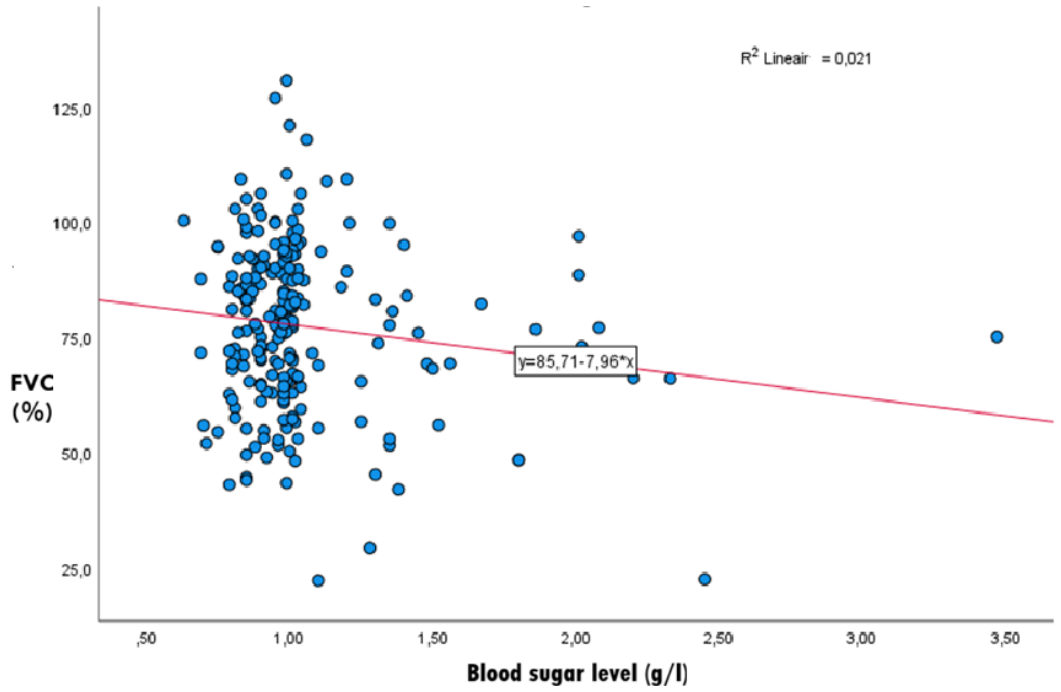

Figure 6: Scatter plot of the theoretical FVC and Asthmatic glycemic figures.

R = -0.143 P = 0.033

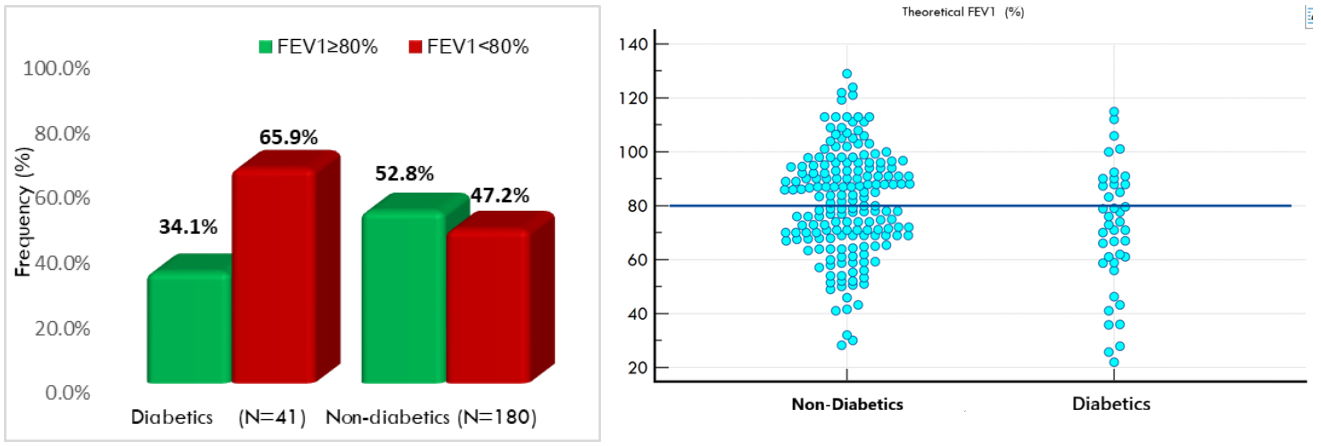

Figure 7: Distribution of asthmatic cases according to tiffeneau and diabetes.

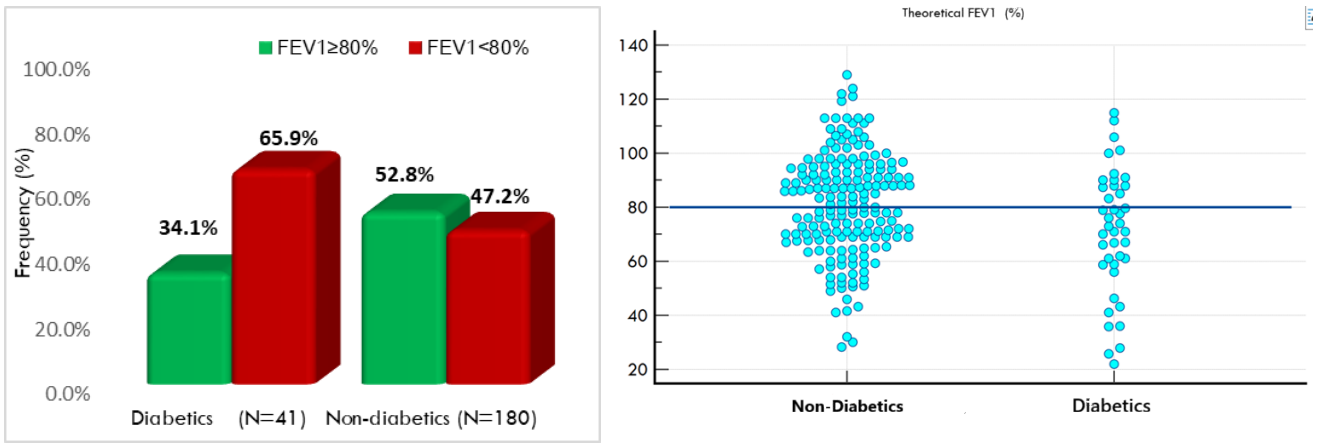

Figure 8: Distribution of asthmatic cases according to tiffeneau vs LLN and diabetes.

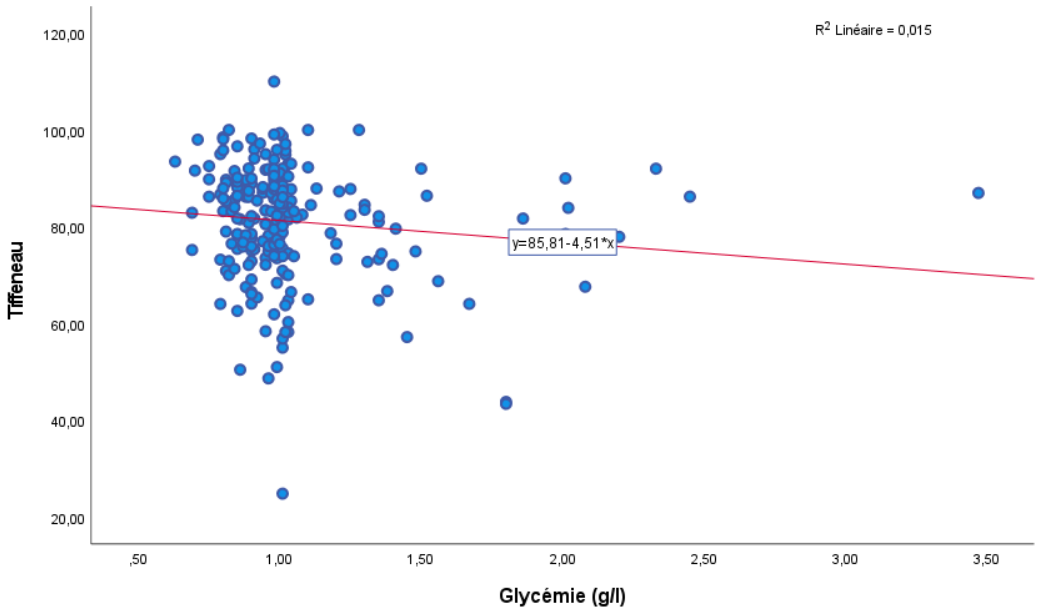

Figure 9: Tiffeneau scatter plot and asthmatic glycemic figures.

about two-thirds of the diabetic population studied. In addition, more than half of them have values below the LLN.

We observed in our case series that FEV1 values decrease as blood glucose levels increase with a negative linear correlation ($p < 0.01$). This result is in agreement with some studies, confirming the negative effect of chronic hyperglycemia on respiratory function.

A majority of diabetic cases have low rates of FVC (68.3%), which is consistent with several studies that have demonstrated the impact of diabetes on FVC. Some other findings from cross-sectional studies show that FVC and FEV1 are lower in adults with diabetes compared to their non-diabetic counterparts [4-7].

Most diabetic patients (75%) have a normal Tiffeneau (> 70%) and 80.5% of diabetics have a Tiffeneau > LLN, as found in the studies by El Fargani and Van den Borst. Other studies show that restrictive ventilatory disorder (reduction in FVC and increase in FEV1/FVC ratio), not obstructive (decrease in FEV1/FVC ratio), is associated with diabetes [5,8-12].

The most common ventilatory disorder in our diabetic case series is PRISM in 41.5% followed by mixed ventilatory disorder in 22% which is consistent with previous studies such as Klein, et al., Zhu, et al. and Hsia, et al. [13-15].

The EPF is largely affected by diabetes because more than two-thirds of the diabetic population has a PEF at less than 80% of its theoretical value [16-20].

Conclusion

Diabetes is associated with moderate, early and global impairment of respiratory function. This condition seems to be related to hyperglycemia, regardless of the type of diabetes. This alteration should be looked for in asthmatics; its pathophysiological mechanism remains to be demonstrated.

However, the existence of pulmonary microangiopathy affecting the alveolar-capillary membrane is the most suggested hypothesis.

The respiratory function of diabetic patients is a topic of interest due to the current development of inhaled insulin therapy as a replacement for the subcutaneous route. However, an alteration in respiratory function linked to diabetes could compromise the bioavailability of these treatments.

Diabetes mellitus is a common comorbid condition in patients with bronchial asthma. In order to reduce the short- and long-term complications of diabetes mellitus, clinicians need to closely monitor patients and improve their self-management of the disease.

Conflict of Interest

No conflict of interest.

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