



Is there a relationship between asthma and diabetes?

Barbara Rogala, Andrzej Bożek & Joanna Gluck

To cite this article: Barbara Rogala, Andrzej Bożek & Joanna Gluck (2019): Is there a relationship between asthma and diabetes?, Journal of Asthma, DOI: [10.1080/02770903.2019.1652642](https://doi.org/10.1080/02770903.2019.1652642)

To link to this article: <https://doi.org/10.1080/02770903.2019.1652642>



Published online: 20 Aug 2019.



Submit your article to this journal [↗](#)



Article views: 26



View related articles [↗](#)



View Crossmark data [↗](#)



Is there a relationship between asthma and diabetes?

Barbara Rogala, MD, PhD^a, Andrzej Bożek, MD, PhD^b, and Joanna Gluck, MD PhD^a

^aClinical Department of Internal Disease, Allergology and Clinical Immunology, Medical University of Silesia, Katowice, Poland;

^bClinical Department of Internal Disease, Dermatology and Allergology, Medical University of Silesia, Katowice, Poland

ABSTRACT

Background: There is an ongoing discussion regarding the coexistence of bronchial asthma and diabetes. The objective of the study was to assess the relationship between asthma and the diabetes course and the influence of corticosteroid therapy in asthma on diabetes control.

Methods: This was a cross-sectional study. There were 2431 adult patients who were selected from 40,015 patients and assigned to subgroups of patients with only asthma, with both asthma and diabetes and with only diabetes. The following parameters were measured: fasting blood glucose level, oral glucose tolerance and glycated hemoglobin (HbA1c).

Results: The value of HbA1c in patients with asthma and diabetes was compared to the value of this parameter in patients suffering only from diabetes: $7.23 \pm 1.73\%$ versus $7.42 \pm 2.09\%$ ($P > 0.05$). The diabetes control criteria were met in 48.5% patients with asthma and concomitant diabetes and in 50.6% patients who suffered only from diabetes. There was a negative relationship between severe asthma and diabetes control. A daily dose of budesonide up to 825 mcg used by asthmatic and diabetic patients had no significant influence on fasting glucose.

Conclusions: The effect of asthma on diabetes does not seem to be significant, except for in patients with severe asthma. Inhaled steroids administered in low or mild doses do not affect fasting glycemia.

ARTICLE HISTORY

Received 28 March 2019

Revised 18 July 2019

Accepted 31 July 2019

KEYWORDS

Bronchial asthma; diabetes; corticosteroids

Introduction

Asthma is mainly driven by Th2-type cells, in contrast to diabetes mellitus, in which Th1-type activity is observed (1–3). Regarding the cross-regulatory characteristics of Th1 and Th2 cells, it can be assumed that asthma and diabetes do not coexist in the same patient population (1–3). In this context, it is worth noting that subjects with diabetes mellitus and their relatives have a significantly higher prevalence of autoimmune diseases (1).

The management of asthma coexisting with diabetes mellitus can be more complicated than that of asthma with no glycemic disturbances. Poor asthma management in this group of patients can be, at least to some extent, the consequence of insufficient cooperation between specialists treating asthma and those treating diabetes (4,5).

It is even more important to note that, despite great progress in the field, both asthma and diabetes remain treatable but not curable.

Comorbidities impact the efficient management of any given disease due to the interrelations of different pathophysiology and/or the interactions of the administered drugs.

The problem with regard to asthma is important for at least two reasons. Asthma is considered a heterogeneous disease whose pathophysiology is very complex (6). Despite the number of new specific therapeutic options that have emerged in recent years, corticosteroids remain the mainstay of asthma therapy. Corticosteroids optimally attenuate airway inflammation and thus control asthma symptoms. Among the many potential side effects of steroid therapy, glucose tolerance disturbances are highlighted (6).

The fear of such side effects originates from the experience of systemic corticosteroid (SCs) therapy. The problem should be analyzed separately with regard to inhaled corticosteroids (ICSs). Many of them have little, if any, relevance to side effects of the kind mentioned above.

CONTACT Andrzej Bożek ✉ andrzejbozek@o2.pl Clinical Department of Internal Disease, Dermatology and Allergology, ul. Skłodowskiej 10, 41-800 Zabrze, Poland.

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/ijas.

© 2019 Taylor & Francis Group, LLC

Moreover, the differentiation of pharmacokinetic and pharmacodynamic features should be considered. There are many stereotypes regarding the coexistence of asthma and diabetes and the safety of the treatment of the disorder.

The objective of the study was to assess the following: the relationship between asthma and diabetes control, the potential effect of diabetes on the course of asthma and the influence of corticosteroid therapy on diabetes control.

Materials and methods

Patients

The group of 40,015 patients' medical charts were screened according to ICD codes (all combinations of asthma and/or diabetes diagnoses) and inclusion criteria (see below) in outpatient clinics. To determine the matching of patients, the propensity score was used to obtain the expected and comparable subgroups of patients with asthma alone, with diabetes and asthma and with diabetes alone. This calculation was performed using a computer program (Allocation Software, Poland). In this way, 2431 patients were selected into the asthmatic subgroup, 1986 into the asthma and diabetes subgroup and 2346 into the diabetes subgroup.

The inclusion criteria for patients with asthma were as follows: age ≥ 18 years, a history of symptoms consistent with a diagnosis of asthma and its severity, according to GINA criteria, for at least 12 months (6), lung function reversibility test showing an increase of $\geq 12\%$ in FEV₁ within 10–40 min following four inhalations of salbutamol aerosol (400 mcg) (6), and asthma therapy (short beta-agonist inhaler plus ICSs with a minimum total daily dose of 200 mcg of budesonide or equivalent, applied separately or in combination with long-acting B2 agonists) for at least 6 months prior to the study. Antileukotrienes and SCs were also allowed.

The inclusion criteria for patients with diabetes were as follows: age ≥ 18 years, a history of type 1 or 2 diabetes: glucose serum level ≥ 11 mmol/l and/or a positive glucose tolerance test (OGTT)—blood glucose level greater than 11.1 mmol/l 2 h after a load of 150 mg of glucose (7,8) and diabetes therapy for at least 6 months prior to the study.

Patients suffering from both asthma and diabetes fulfilled the diagnostic criteria for both diseases.

The exclusion criteria were as follows: other concomitant serious unstable diseases, the use of SCs in the month before the study, problems with cooperation, and asthma-COPD overlap syndrome.

The permission to publish the data were obtained from all the centers. The study was approved by the local Ethics Committees in Medical University of Silesia (Katowice, Poland), and all patients signed informed consent forms.

Methods

Study design

A multicenter, prospective cross-sectional study was performed from 2016 to 2017.

Protocol

A detailed questionnaire concerning the patients' personal and family history was completed.

In all studied patients with diabetes, the following procedures were performed: random blood glucose test, a blood sample was taken at a random time (mmol/l), fasting blood glucose test: a blood sample was taken after an overnight fast (mmol/l), oral glucose tolerance test: after the overnight fasting, the blood glucose level was measured and again in 2 h after the load of 150 mg glucose (mmol/l), test of glycated hemoglobin (HbA1c) levels in blood serum (%), measurement of blood pressure; measurement of LDL cholesterol in blood: a blood sample was taken after an overnight fast (mmol/l), administration of the Asthma Control Questionnaire (ACQ) (only in asthmatic patients) and basic spirometry with bronchial flow analysis (LUNGTEST 1000, MES, Cracow POLAND).

Control of asthma was confirmed if the ACQ score was below 1.0.

The severity of asthma was assessed retrospectively based on GINA criteria. The treatment, daily symptoms, and episodes of asthma exacerbation were analyzed (6).

Diabetes control criteria were as follows: HbA1c $\leq 6.5\%$, serum blood concentration of LDL cholesterol ≤ 2.6 mmol/l and blood pressure $< 140/90$ mmHg (8).

Data analysis

A descriptive analysis was performed with means and standard deviation. The one-way ANOVA test with a *post hoc* Fisher's LSD test was used to compare the characteristic parameters of the study subgroups. These parameters included age, BMI, sex, smoking, severity of asthma, education level, the presence of hyperlipidemia, arterial hypertension and heart failure. Differences were considered significant at $P < 0.05$.

A logistic multiple regression analysis was performed to identify independent risk factors for diabetes control. First, a univariate analysis was carried out to see how each potential variable (age, sex, level of education, duration of disease, the presence of asthma, episodes of asthma exacerbation, score obtained in asthma control questionnaire, family history of asthma, the presence of atopy, BMI) affected the probability of diabetes control. Variables that were not significant in this analysis were excluded. In the second step, variables found to be statistically significant (presented in Table 2) were tested in a combined analysis that indicated poor or good influence on diabetes control. The results are presented as odds ratios (ORs) and 95% confidence intervals. An OR = 1 for a given variable meant that this variable did not influence diabetes control. The Pearson test was used to assess the correlation between HbA1c%, ACQ scores, fasting glucose and random glucose in blood. This test was also used to find a correlation between fasting glucose and daily doses of inhaled steroids used by patients, calculated as budesonide in mcg. Additionally, in this analysis, a coefficient of determination was used to assess how the difference in fasting glucose (every 0.1 mmol/l) can be explained by a difference in the second variable (every 25 mcg of daily doses of budesonide).

Results

Finally, 2341 patients with asthma alone, 1986 patients with asthma and diabetes and 2346 patients with diabetes alone were included in the analysis.

The characteristics of the groups of subjects studied are presented in Table 1. Patients with diabetes had a small but significantly higher BMI than did patients in other subgroups. They also had more frequent hyperlipidemia.

The relationship between asthma and diabetes control

There was no significant relationship between the coexistence of asthma and the control of diabetes in patients with severe asthma. The value of HbA1c in patients with asthma and diabetes was comparable with that estimated in patients with only diabetes: $7.23 \pm 1.73\%$ versus $7.42 \pm 2.09\%$, respectively ($p = 0.41$). The mean fasting glucose level was comparable between the analyzed groups (5.41 ± 1.87 mmol/l versus 5.01 ± 0.84 mmol/l, $p = 0.24$).

The diabetes control criteria (see Methods) were met in 964 (48.5%) patients with asthma and concomitant diabetes and in 1187 (50.6%) patients with diabetes alone. Variables such as male sex or age below 60 or the presence of severe asthma were significantly associated with worse diabetes control. There were no similar associations for other variables. The detailed data are presented in Table 2.

The potential effect of diabetes on the course of asthma

The prevalence of patients with full control of their asthma who obtained an ACQ score <1.0 was similar in the group with asthma and in the group with asthma and coexisting diabetes: 1509 (62.1%) versus 1164 (58.6%), respectively, $p = 0.12$. However, the multiple logistic regression model revealed that patients with severe asthma and concomitant diabetes had a lower chance (OR = 0.37) of gaining full asthma control, as indicated by an ACQ score below 1.0, than did those who had only severe asthma (OR = 0.85).

There was no correlation between HbA1c or fasting blood glucose and ACQ scores (Figures 1 and 2).

Table 1. Characteristics of the study groups.

	Asthma $n = 2431$	Asthma and diabetes $n = 1986$	Diabetes $n = 2346$
Mean age (range; in years)	45.3 (18–88)	44.7 (18–90)	42.1 (18–89)
Mean BMI (kg/m^2)	24.1	25.9	29.2 ^a
Female (%)	48.2	49.2	46.2
Smoking (pack-years)	7.5	7.5	6.8
Higher education (%)	39.8%*	29.9%	25.3%
Severe asthma (%)	373 (15.3)	297 (14.9)	—
Moderate asthma (%)	1,119 (46)	951 (47.8)	—
Mild asthma (%)	939 (38.6)	738 (37.2)	—
Episodes of asthma exacerbation per patient per year	0.47	0.39	—
Hyperlipidemia ^b (%)	21.2%	33.9**	34.1**
Arterial hypertension ^c (%)	32.7%	33.4%	35.2%
Heart failure (%)	23.1%	29.1%	30.1%

BMI: body mass index.

^aSignificant differences between patients with diabetes versus other groups (one-way ANOVA with post hoc LSD Fisher test, $p < 0.05$).

^bThe criteria of hyperlipidemia were as follows: LDL-C > 2.6 mmol/l and/or triglycerides (TG) ≥ 1.7 mmol/l; ^c140/80. ^aSignificant differences between patients with diabetes versus other groups (one-way ANOVA with post hoc LSD Fisher test, $p < 0.05$).

*Significant differences between patients with asthma versus other groups ($p < 0.05$); ** significant differences between patients with asthma and concomitant diabetes and patients with diabetes versus other groups ($p < 0.05$).

However, the random glucose blood test was positively correlated with the ACQ score in that group of patients (Figure 3).

Table 2. Multiple logistic regression for diabetes control of asthmatic patients with concomitant asthma and with diabetes alone.

Variables	Diabetes control	
	OR (95%CI)	P
AD <i>n</i> = 1986	0.98 (0.82–1.21)	>0.05
D <i>n</i> = 2346	1.10 (0.87–1.29)	>0.05
Female AD <i>n</i> = 977	1.12 (0.76–1.42)	>0.05
Female D <i>n</i> = 1084	1.10 (0.92–1.30)	>0.05
Male AD <i>n</i> = 1009	1.16 (0.97–1.42)	<0.05
Male D <i>n</i> = 1262	1.64 (0.87–2.31)	<0.05
<60 years AD <i>n</i> = 1116	1.34 (1.09–1.85)	<0.05
<60 years D <i>n</i> = 1456	1.78 (1.54–2.86)	<0.05
≥60 years AD <i>n</i> = 870	1.29 (1.02–1.73)	>0.05
≥60 years D <i>n</i> = 890	0.93 (0.56–1.33)	>0.05
ACQ score (only AD)		
≤1 <i>n</i> = 1164	0.86 (0.54–1.39)	>0.05
>1 <i>n</i> = 822	0.98 (0.78–1.94)	>0.05
BMI		
≥25 AD <i>n</i> = 978	0.92 (0.48–1.22)	>0.05
≥25 D <i>n</i> = 1041	1.09 (0.52–1.31)	>0.05
Smokers		
AD <i>n</i> = 478	0.89 (0.47–1.61)	>0.05
D <i>n</i> = 679	0.43 (0.22–0.58)	>0.05
Nonsmokers		
AD <i>n</i> = 1508	1.16 (0.78–1.42)	>0.05
D <i>n</i> = 1752	1.02 (0.88–1.37)	>0.05
Length of asthma duration (only AD)		
<5 years AD <i>n</i> = 1002	1.08 (0.80–1.41)	>0.05
<5 years D <i>n</i> = 984	1.21 (0.97–1.56)	>0.05
Severe asthma (only AD)		
<i>n</i> = 297	1.55 (1.32–2.21)	<0.05

AD: asthmatic patients with concomitant diabetes; D: patients with diabetes alone; ACQ: Asthma Control Questionnaire; OR = 1: no influence on diabetes control, OR > 1: positive influence on diabetes control (for $p > 0.05$).

Male AD $P = 0.016$; Male D $P = 0.023$; <60 years AD $P = 0.028$; <60 years D $P = 0.011$; severe asthma $P = 0.031$.

The influence of corticosteroid therapy on diabetes control

The type and dose of the ICSs used by patients with asthma are presented in Table 3. In patients with asthma and diabetes, a positive mild correlation between daily doses of inhaled steroids used by patients, calculated as budesonide in mcg, and an increase in fasting glucose (but not random glucose) levels in blood was found. However, in the analysis of the coefficient of determination, this positive correlation started from a dose greater than 825 mcg of budesonide (Figure 4).

Regardless of this observation, there was no correlation between daily dose of ICS and control of diabetes, according to criteria, in those patients (Pearson correlation test, $p = 0.56$).

In patients with asthma alone, any ICS daily doses had no impact on fasting blood glucose, random blood glucose or HbA1c ($p = 0.39$).

In 452 (22.8%) patients suffering from both asthma and diabetes, SCs were used in asthma therapy, with a mean dose of 12.2 ± 6.9 mcg prednisone and a mean of 8.3 ± 2.2 days per year per patient. In those groups, SCs were a negative predictor of the lack of diabetes control for a daily dose of $\geq 18.7 \pm 5.3$ mcg prednisone during a minimum of 9.4 ± 1.6 days per year per patient (OR = 0.48 (0.41–0.62), $p < 0.05$).

There was no significant long-term effect of SCs in the past 12 months on the results for fasting and random blood glucose tests during the study protocol.

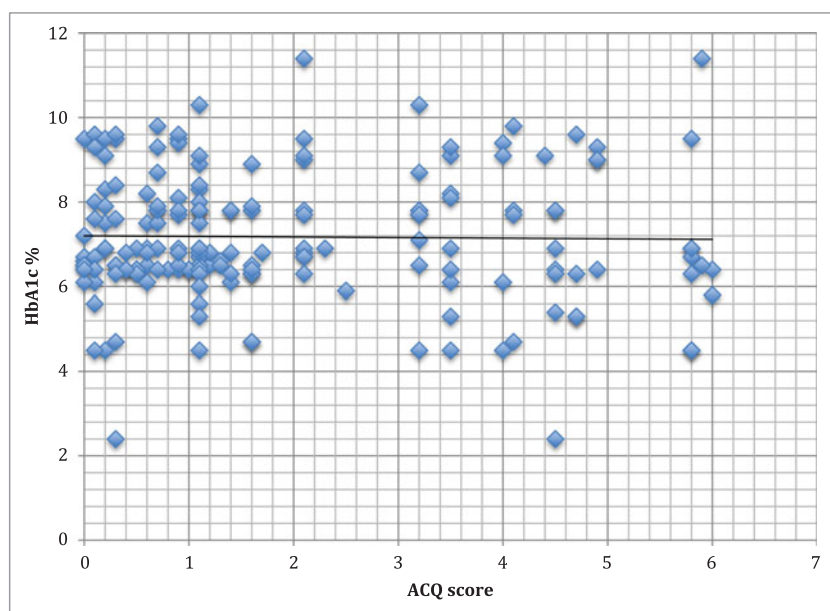


Figure 1. No correlation between HbA1c and ACQ scores in patients with asthma and concomitant diabetes (Pearson correlation test, $p = 0.28$).

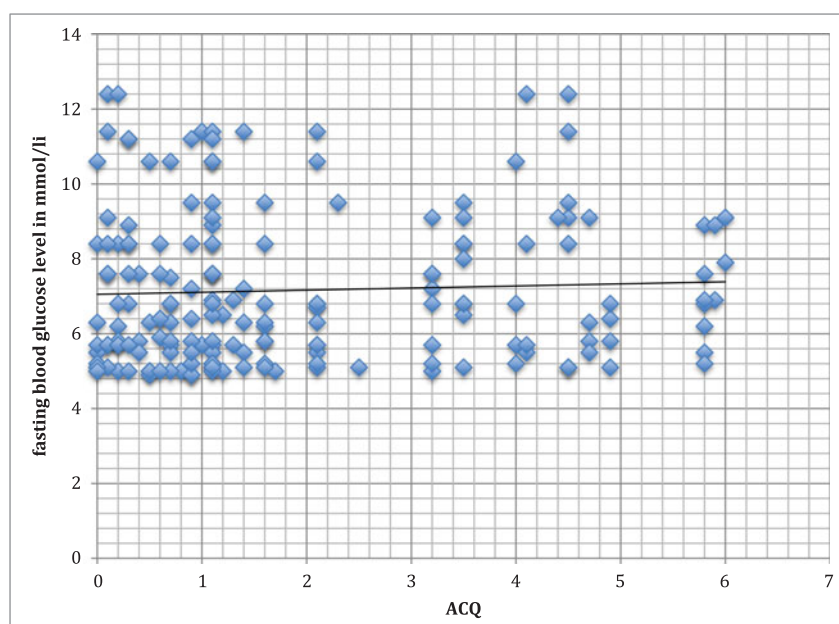


Figure 2. No correlation between fasting blood glucose and ACQ scores in patients with asthma and concomitant diabetes (Pearson correlation test, $p = 0.31$).

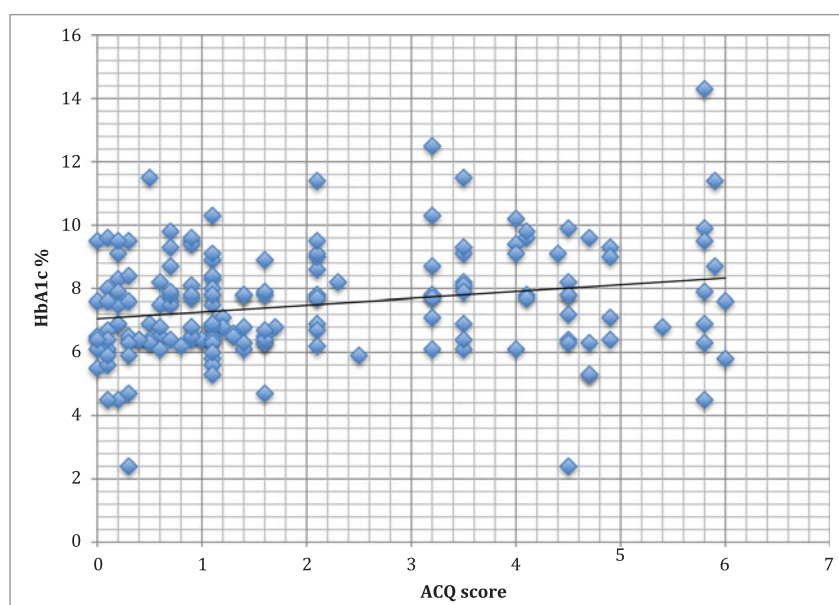


Figure 3. A positive correlation between random blood glucose and ACQ scores in patients with asthma and concomitant diabetes (Pearson correlation test, $p = 0.03$).

Table 3. The type and dose of the inhaled corticosteroids used by patients with asthma.

Number of patients with asthma (%)	Type of ICS	Mean daily dose $\pm$ SD
1672 (35)	Fluticasone propionate	545 $\pm$ 185 mcg
1385 (29)	Ciclesonide	240 $\pm$ 124 mcg
1290 (27)	Budesonide	458 $\pm$ 162 mcg
430 (9)	Beclomethasone	185 $\pm$ 92 mcg
Total: 4777	Converted to budesonide	745 $\pm$ 324 mcg

ICS: inhaled corticosteroids; SD: standard deviation.

Discussion

Based on the obtained results, the presence of severe asthma negatively influenced diabetes control. However, this finding did not affect other patients with mild or moderate asthma, who were predominant in this observation. In the majority of patients suffering from both asthma and diabetes, the key parameters of diabetes control, HbA1c, LDL, and

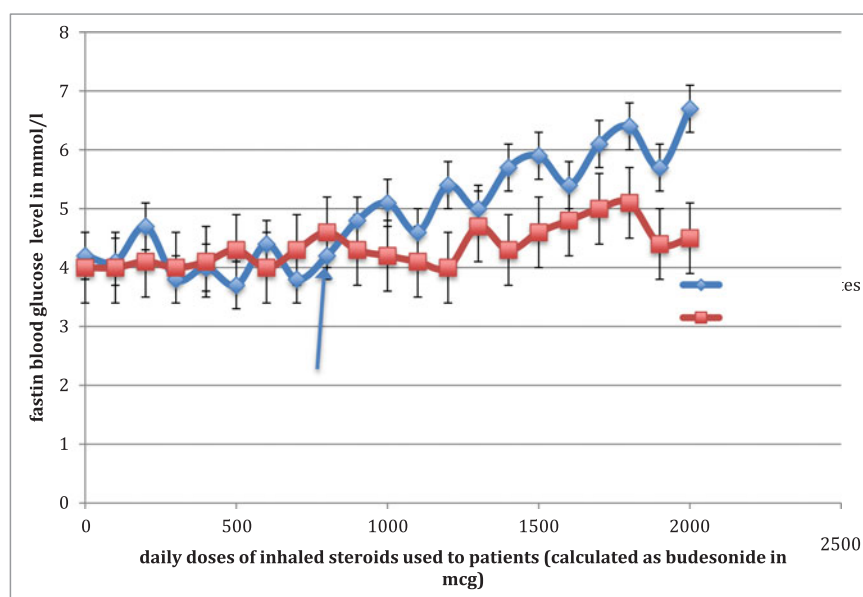


Figure 4. A positive correlation between fasting glycemia and a daily dose of up to 825 mcg of inhaled budesonide (see arrow) in patients with asthma and diabetes (Pearson test with coefficient of determination, $p = 0.03$). No correlation between analyzed parameters in patients with asthma alone ($p = 0.14$).

blood pressure were in the normal range. This finding suggests that asthma does not always have a negative influence on diabetes control. However, poorer diabetes control was observed in men, in patients younger than 60 years of age or in patients with severe asthma. This finding is partially consistent with the results of other studies that indicate generally poor control of diabetes in younger patients, which might explain this phenomenon, at least to some extent (7,9–11).

Patients with severe asthma concomitant with diabetes had a lower chance of gaining asthma control than those with asthma but not with diabetes (9,12). This finding remains in accordance with other observations that patients with severe asthma and comorbid conditions (e.g. diabetes) have a greater risk of poor asthma control (12). This relationship can be explained to some extent by the frequent use of SCs in that group of asthmatics and high doses of ICS. Similar observations were published by other authors (13).

However, it is worth emphasizing once again that this observation is related only to patients with severe asthma who are not the dominant group. Our results remain in agreement with previously published data that highlight the rare coexistence of asthma and diabetes, which indirectly suggests a weak predisposition to diabetes development in asthmatics despite corticosteroid therapy. This observation is important in the treatment of asthma, mainly with ICSs, since the bioavailability of such formulations is low (14).

The influence of corticosteroid therapy on the control of diabetes has been analyzed previously. Despite the common opinion that ICSs always have a negative effect on glucose metabolism, there is not much evidence for this opinion in the literature (14). There are data, although few in number, that provide proof of the risk of ICS therapy in the development of glucose tolerance disturbances (15,16). Nevertheless, it is worth keeping in mind that the safety profile of ICS is excellent at the recommended doses, which are sufficient to control most asthma cases. In our study, only relatively high daily doses of ICSs (up to 825 mcg of budesonide, as used by our patients) did not disturb diabetes control. This finding is consistent with those of other studies, which confirms the safety of ICS at doses sufficient for proper asthma control (17). It worth keeping in mind that for asthma treatment, we use anti-inflammatory, rather than immunosuppressive, doses of corticosteroids. The obtained results prove that high doses of ICS may affect glucose metabolism but ultimately do not affect diabetes control.

This finding indicates that in patients with asthma concomitant with diabetes mellitus, the lowest effective dose of steroids with the lowest possible bioavailability should be administered. The main highlight of the data presented is a pragmatic concept that emphasizes the safety of ICSs in terms of glucose tolerance disturbances.

A reasonable dose of steroids to meet the requirements of the common stepwise pharmacotherapy is the best possible approach to asthma management,

and it can be safe in patients with diabetes or glucose tolerance disturbances.

There were some limitations of the study. As mentioned above, more asthmatic features and analysis of subgroups with different asthma phenotypes in relation to diabetes could increase the precision of our observations. The same would be the case with respect to diabetes (such as the analysis of family history). Future studies will examine this issue further. In the context of the results of our study, it would be valuable to take into account the phenotypes/endotypes of both asthma and diabetes. It is worth noting that the estimation of the coexistence of the diseases was not within the scope of the study.

Conclusions

A negative relationship between severe asthma and diabetes control was observed. However, there were no similar observations in other asthmatics. Inhaled steroids in small and medium doses used in patients with asthma do not affect the control of diabetes. However, this effect should be taken into account when high doses of ICS are used in asthma treatment.

Declaration of interest

The authors declare no conflict of interest.

References

1. Rabin RL, Levinson AI. The nexus between atopic disease and autoimmunity: a review of the epidemiological and mechanistic literature. *Clin Exp Immunol* 2008;153:19–30. doi:10.1111/j.1365-2249.2008.03679.x.
2. Alves C, Diniz AB, Souza MB, Ponte EV, Araújo MI. Controversies in the association between type 1 diabetes and asthma. *Arq Bras Endocrinol Metabol* 2007; 51:930.
3. Perez MK, Piedimonte G. Metabolic asthma: is there a link between obesity, diabetes, and asthma? *Immunol Allergy Clin North Am* 2014;34:777–784. doi:10.1016/j.iac.2014.07.002.
4. Visca D, Pignatti P, Spanevello A, Lucini E, La Rocca E. Relationship between diabetes and respiratory diseases-clinical and therapeutic aspects. *Pharmacol Res* 2018;137:230–235. Epub 2018 Oct 9. doi:10.1016/j.phrs.2018.10.008.
5. Wright NP, Wales JK. The incidence of hypoglycaemia in children with type 1 diabetes and treated asthma. *Arch Dis Child* 2003;88:155–156. doi:10.1136/ad.88.2.155.
6. Global Initiative for Asthma - Global Initiative for Asthma - GINA. Available from: <https://www.ginasthma.org> 2018 [last accessed 10 October 2018].
7. Definition and diagnosis of diabetes - World Health Organization. Available from: <https://www.who.int/diabetes/publications/Definition%20and%20diagnosis%20of%20diabetes> [last accessed data: 19 January 2019].
8. Zalecenia kliniczne dotyczące postępowaniu u chorych na cukrzycę. 2017. Stanowisko Polskiego Towarzystwa Diabetologicznego. Available from: <https://www.cukrzyca.info.pl/content/>. [last accessed data: 22 January 2019].
9. Rana JS, Mittelman MA, Sheikh J, Hu BF, Manson JE, Colditz GA, et al. Chronic obstructive pulmonary disease, asthma, and risk of type 2 diabetes in women. *Diab Care* 2004;10:2478–2484. doi:10.2337/diacare.27.10.2478.
10. Forno E. Asthma with adults in diabetes: treat their diabetes with metformin, improve their asthma?. *Respirology* 2016;21:1144–1145. doi:10.1111/resp.12869.
11. Crowley MJ, Holleman R, Klamers ML, Bosworth HB, Edelman D, Heisler M. Factors associated with persistent poorly controlled diabetes mellitus: clues to improving management in patients with resistant poor control. *Chronic Illn* 2014;10:291–302. doi:10.1177/1742395314523653.
12. Sweeney J, Patterson CC, Menzies-Gow A, Niven RM, Mansur AH, Bucknall C, Chaudhuri R, Price D, Brightling CE, Heaney LG. Comorbidity in severe asthma requiring systemic corticosteroid therapy: cross-sectional data from the Optimum Patient Care Research Database and the British Thoracic Difficult Asthma Registry. *Thorax* 2016;71:339–346. doi:10.1136/thoraxjnl-2015-207630.
13. Volmer T, Effenberger T, Trautner C, Buhl R. onsequences of long-term oral corticosteroid therapy and its side-effects in severe asthma in adults: a focused review of the impact data in the literature. *Eur Respir J* 2018;52:1800703. doi:10.1183/13993003.00703-2018.
14. Egbunu F, Antonio FA, Edavalath M. Effect of inhaled corticosteroids on glycemic status. *Open Respir Med J* 2014;8:101–105. doi:10.2174/1874306401408010101.
15. Gulcan E, Bulut I, Toker A, Gulcan A. valuation of glucose tolerance status in patients with asthma bronchiale. *J Asthma* 2009;46:207–209. doi:10.1080/02770900802627302.
16. Faul JL, Wilson SR, Chu JW, Canfield J, Kushner WG. The effect of an inhaled corticosteroid on glucose control in type 2 diabetes. *Clin Med Res* 2009;7: 14–20. Epub 2009 Feb 26. doi:10.3121/cmr.2009.824.
17. Ernst P, Suissa S. Systemic effects of inhaled corticosteroids. *Curr Opin Pulm Med* 2012;18:85–89. doi:10.1097/MCP.0b013e32834dc51a.