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Prevalence of Asthma Bronchiale in the Czech Republic and its Economic Burden

[1]Richter Josef, [1]Kral Vlastimil, [1]Rajnohova Dobiasova Lucie, [2]Svozil Vladimir, [3]Pohunek Petr and [4]Vetvicka Vaclav

[1]Regional Institute of Public Health, Ústí nad Labem, Czech Republic
[2]Sanatorium Edel, Zlaté Hory, Czech Republic
[3]Department of Pediatrics, 2nd Faculty of Medicine, Charles University in Prague, Czech Republic
[4]Department of Pathology, School of Medicine, University of Louisville, Louisville, KY, USA

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Corresponding Author:
Vaclav Vetvicka
Department of Pathology, University of Louisville, 511 S. Floyd, Louisville, KY 40292, USA
Email: Vaclav.vetvicka@louisville.edu

Abstract: Asthma Bronchiale (AB) is a chronic inflammatory disorder of the airways currently affecting around 350,000,000 patients in the world. A steady increase in prevalence of this disease was the incentive for our study of the prevalence of AB in the Czech Republic. Special attention was focused on possible differential regional incidence. We found that prevalence of this disease in an age group 0-14 years is 5.21%, in age group of 15-19 is 11.5%. In the 2000-2013 period, we observed a 268% increase in the 0-14 group and 685% increase in the 15-19 group. Using published materials, we used medical costs values from other European countries, which are in range of 600 to 3,200 dollars to calculate the finacial burden in the Czech Republic. When we used a conservative estimate of $1,200, the total costs of AB treatment in the 0-14 years group is $66,475,200 per year. When compared with the year 2000, the increase in financial costs is more than $50,000,000, with the anticipated increase of $30,000,000 every single year. These findings indicate that there is a necessity to increase interest in primary prevention and early diagnosis of this disease.

Keywords: Asthma, Asthma Bronchiale, Economic Impact, Population, Costs

Introduction

Asthma Bronchiale (AB) is a chronic inflammatory disorder of the airways currently affecting app. 350 million patients worldwide (Aldubi *et al*., 2015; Bahadori *et al*., 2009; Busaidi-Al *et al*., 2013; D'Amato *et al*., 2015; Litonjua and Weiss, 2007). Prevalence of this disease is steadily increasing, particularly in industrial countries and in some European countries is already higher than 10% of infantile population (Litonjua and Weiss, 2007; Bedouch *et al*., 2012; Doz *et al*., 2013; Kasak, 2005; Negro *et al*., 2007). This trend is very similar in the Czech Republic, particularly in the infantile population (Kasak, 2005; Petru, 2008; Pohunek and Slamova, 2009; Pohunek *et al*., 2009). Despite the fact that in recent years there is considerable attention focused on diagnostic of all allergic diseases including AB, a full and precise diagnosis is still often unsatisfactory, with subsequent problems starting treatment at the earliest start of this disease (Bedouch *et al*., 2012; Doz *et al*., 2013; Pakhale *et al*., 2011; Petru, 2008; Pohunek *et al*., 2009; Zhang *et al*., 2015). Problems in evidence of AB, leading to disproportional evidence of AB in individual regions, are also significant (Gudelj *et al*., 2012; Hansen *et al*., 2012). An exact and early diagnosis can significantly reduce progression of clinical manifestation of AB and thus strongly lower financial burden (Bahadori *et al*., 2009; Litonjua and Weiss, 2007; Edwards *et al*., 2011; Doz *et al*., 2013; Pohunek *et al*., 2009).

Prevalence of AB is constantly increasing, even if this trend is different in individual countries (Accordini *et al*., 2013; Bahadori *et al*., 2009; Litonjua and Weiss, 2007; D'Amato *et al*., 2015; Doz *et al*., 2013; Gudelj *et al*., 2012; Kim *et al*., 2013; Wong *et al*., 2013; Zalewska *et al*., 2013). Numerous inductors are considered to be responsible for an increase in AB prevalence, among others it is urbanization and environmental pollution, but also more precise diagnostic and registration (Anderson *et al*., 2012; Bonds and Midoro-Horiuti, 2013; Daghri-Al *et al*., 2013; D'Amato *et al*., 2015; Lamnisos *et al*., 2013; Patel *et al*., 2012). The estimated increase in AB prevelance for the year 2025 is at least 30% (Bahadori *et al*., 2009; Sadatsafavi *et al*., 2010; To *et al*., 2013; Wong *et al*., 2013).

This trend started serious discussion in many countries concerned with rising economic burden, necessary for the care of patients. These economic problems include both direct and indirect costs. The ever increasing trend of AB occurrence is the reason of this review.

Materials and Methods

Resources

Data for evaluation of AB prevalence in individual European countries were obtained by a systematic search of following databases: PubMed NL, Home-PubMed-CBI, Europe-PubMed Central, Biomedical Search, Free Medical Journals, Amedeo Services and NIH-National Library of Medicine. We used data from European countries for a 2004-2011 interval and calculated average prevelance values. For the Czech Republic, we used data from Czech Health Statistics Yearbook published by the Ministry of Health for years 2006-2013 (UZIS, 2013).

For calculation of costs of AB treatment we used primarily direct costs. Indirect costs and additional costs such as effects on social and economical situation of the entire family and work or school absence were not used due to the highly conflicting data published in individual countries (Pasquale *et al*., 2012; Sadatsafavi *et al*., 2010; Tan *et al*., 2009; Zehraeus *et al*., 2010).

Results

Epidemiology of Asthma Bronchiale

In general, literature describes a steady and significant increase in AB prevalence (D'Amato *et al*., 2015; Doz *et al*., 2013; Kasak, 2005; Litonjua and Weiss, 2007). In Asia, the prevalence is around 2-4%, in industrial countries (such as Canada, Australia, Ireland, Great Britain, Sweden and New Zealand) reached 15-20% (D'Amato *et al*., 2015). This information led us to analyze the situation in Europe. We based our investigation on published data from 2006-2013 period and we calculated average values for each individual country. Appearance of AB in Europe is shown in Fig. 1. It clearly shows higher appearance in the industrial countries of Western Europe and Scandinavia. On the other hand, Eastern Europe shows significantly lower levels. In the Czech Republic, the situation was significantly different among individual regions (Fig. 2). The highest appearance of AB was found in eastern regions of the republic, where AB can be found more than twice as often as in the rest of country.

Comparing data from 2000 and 2013 we can observe a clear and statistically significant increase of AB. With respect to possible risk factors such as geographical location, effects of irradiation, urbanization, environmental pollution, smoking or forestation shown in Table 1 (D'Amato *et al*., 2015; Toskala and Kennedy, 2015), no significant differences in AB appearance were found.

Economical Impact

The economic impact of AB treatment has been the subject of numerous studies (Accordini *et al*., 2013; Bahadori *et al*., 2009; Bedouch *et al*., 2012; Doz *et al*., 2013; Kirsch *et al*., 2013; Meer *et al*., 2011; Negro *et al*., 2007; Pakhale *et al*., 2011; Rodriguez *et al*., 2011; Tan *et al*., 2009; Zehraeus *et al*., 2010). Direct costs include cost of ambulatory care, hospitalization, drugs, diagnostics, research and education. Indirect costs include loss of employment or school attendance, loss in productivity, family costs and other financial problems (Accordini *et al*., 2013; Bahadori *et al*., 2009; Busaidi-Al *et al*., 2013; D'Amato *et al*., 2015; Doz *et al*., 2013; Meer *et al*., 2011; Sadatsafavi *et al*., 2010). Calculation of either direct or indirect costs in the Czech Republic is rather difficult. Costs of drugs and diagnostics are similar to other countries; total costs of AB treatment are shown in Table 2. It is important to note that the calculation of costs is substantially different among individual countries. Some Arabic countries and South Korea reported $5,600/year as a maximal costs. Indirect costs described in numerous studies vary from 15 to 67% of total costs (Honkoop *et al*., 2011; Pakhale *et al*., 2011; Tan *et al*., 2009; Zehraeus *et al*., 2010). Aproximate costs of AB treatment in the Czech Republic was calculated based on the cost of drugs, diagnostics and screening of patients in our hospital.

In 2013, Czech Republic registered 85,644 asthmatics in 0-14 year age group. At the same time, this population of children represented a total of 1,470,952 individuals; therefore the segment of AB patients in this group is 5.21%. Total cost of a year of treatment was $102,772,800. Our hospital showed 650 patients with costs ranging from $300 to $3,440 with an average cost of $1,200. Using the same calculation, the cost of treating one patient in 2001 was $44,000,400.

In the 15-19 year group we registered 13,233 patients in 2001, in the year 2013 it was already 55,396 patients. The costs rose from $15,900,000 to $66,500,000. As can be seen from the growing trend, the significant growth of patients in both age groups is followed by similarly significant increase in costs. In addition, there are no doubts that this trend will continue. An estimate for 2020 suggests that without changes in treatment and/or registration, the costs will increase 30 to 50%. All this strongly underlines the need to come up with primary preventive measurements and with earlier and more accurate clinical and laboratory diagnostic and earlier treatment of AB.

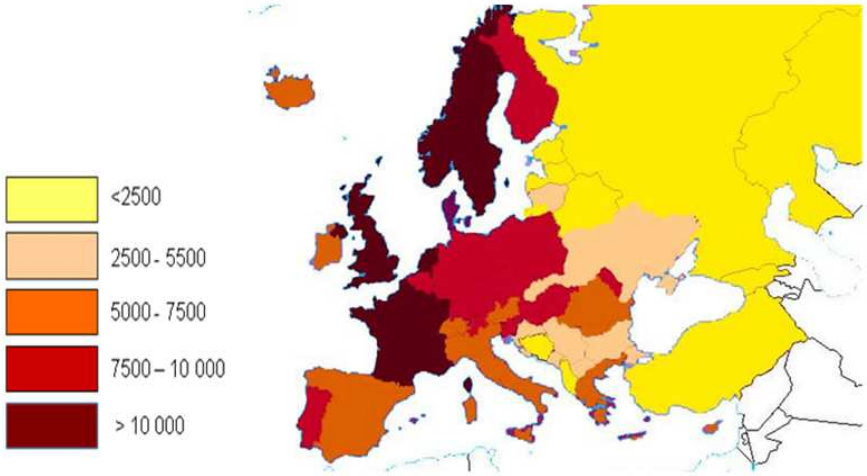

Fig. 1. Asthmabronchiale prevalence in Europiancoutries (2008-2012). Asthma bronchiale cases per 100 000 inhabitants

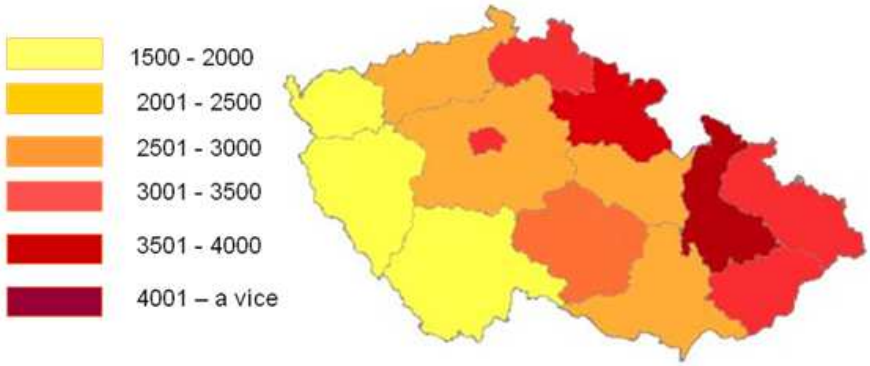

Fig. 2. Asthmabronchiale in regions of the Czech Republic (2013). Asthma bronchiale cases per 100 000 inhabitants

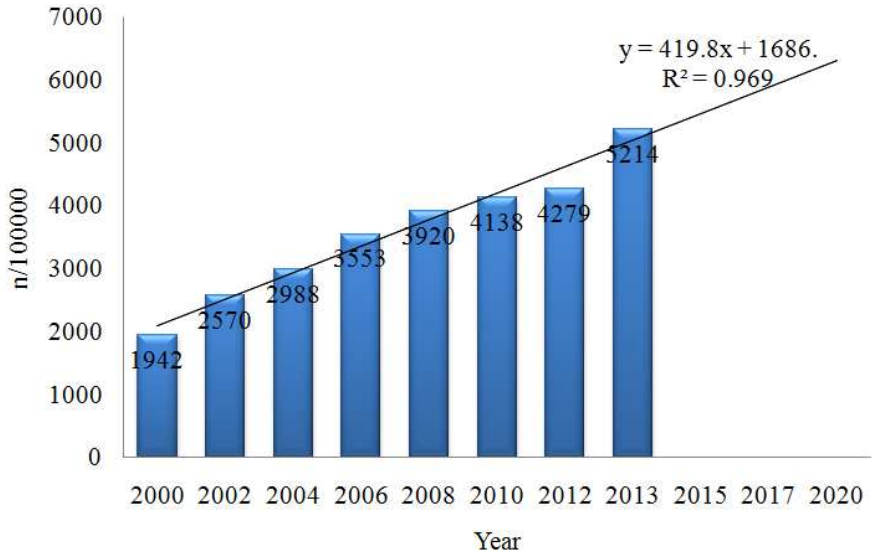

Fig. 3. Asthma bronchiale prevalence in children of the Czech republic-(Age years 0-14)-Followed up patients per 100 000 inhabitants

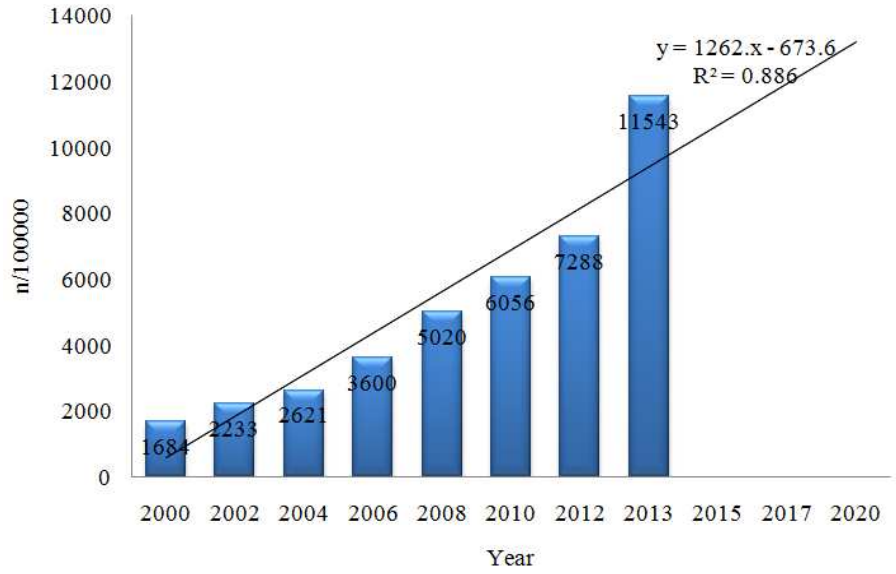

Fig. 4. Asthma bronchiale prevalence in children of the Czech republic-(Age years15-19)-Followed up patients per 100 000 inhabitants

Table 1. Risk factors asthma bronchiale induction

Risk factor	Reference
Allergy	Aldubi *et al*. (2015; Anderson *et al*., 2012; Bahadori *et al*., 2009; Bedouch *et al*., 2012; Bonds and Midoro-Horiuti, 2013; Gudelj *et al*., 2012; Patel *et al*., 2012)
Genetics	Karmaus *et al*. (2013; Kim *et al*., 2013; Kirsch *et al*., 2013; Pasquale *et al*., 2012; Patel *et al*., 2012; Petru, 2008; Rodriguez *et al*., 2011)
Sex	Anderson *et al*. (2012; Bedouch *et al*., 2012; Daghri-Al *et al*., 2013; Patel *et al*., 2012)
Locality/UV/radiation	Aldubi *et al*. (2015; Daghri-Al *et al*., 2013; D'Amato *et al*., 2015; Doz *et al*., 2013; Edwards *et al*., 2011; Karmaus *et al*., 2013; Kirsch *et al*., 2013; To *et al*., 2012; Wong *et al*., 2013; Zalewska *et al*., 2013)
Locality of residence	Krstic (2011; Pasquale *et al*., 2012; Pittman *et al*., 2012; Rodriguez *et al*., 2011; To *et al*., 2012)
Urbanization	Rodriguez *et al*. (2011; Wong *et al*., 2013)
Air pollution	Anderson *et al*. (2012; Bahadori *et al*., 2009; Daghri-Al *et al*., 2013; Edwards *et al*., 2011; Karmaus *et al*., 2013; Patel *et al*., 2012; Petru, 2008; Stoner *et al*., 2013; Toru *et al*., 2015)
Diesel fuel	Busaidi-Al *et al*. (2013; Subbarao *et al*., 2009)
PCB-PAH	Busaidi-Al *et al*. (2013; Subbarao *et al*., 2009)
Estrogens	Bonds and Midoro-Horiuti (2013)
Pets	Subbarao *et al*. (2009; Wong *et al*., 2013)
Socioeconomical influence	Bahadori *et al*. (2009; Honkoop *et al*., 2011; Kim *et al*., 2012; Kirsch *et al*., 2013; Pittman *et al*., 2012; Rodriguez *et al*., 2011; Subbarao *et al*., 2009)
Smoking	Doz *et al*. (2013; Gudelj *et al*., 2012; Karmaus *et al*., 2013; Lamnisos *et al*., 2013; Patel *et al*., 2012; Pittman *et al*., 2012; Subbarao *et al*., 2009; To *et al*., 2012)
Passive smoking	Gudelj *et al*. (2012; Kim *et al*., 2012; Lamnisos *et al*., 2013; Patel *et al*., 2012; Pittman *et al*., 2012; Pohunek *et al*., 1999; Stoner *et al*., 2013; Subbarao *et al*., 2009)
Nutrition	Daghri-Al *et al*. (2013; Patel *et al*., 2012; Rodriguez *et al*., 2011; Subbarao *et al*.,2009)
Vitamin D	Aldubi *et al*. (2015; Krstic, 2011; Litonjua and Weiss, 2007)
Obesity	Negro *et al*. (2007; Patel *et al*., 2012)
Helicobacter pylori	Karimi *et al*. (2013)
Endotoxins	Subbarao *et al*. (2009; Wong *et al*., 2013)
Specific IgE	Song *et al*. (2013)
Exposure to allergens	Patel *et al*., 2012; Pittman *et al*., 2012; Subbarao *et al*., 2009)
Exposure to molds	Patel *et al*. (2012; Petru, 2008; Pohunek *et al*., 1999; Pohunek and Slamova, 1999; Toru *et al*., 2015; Pringle, 2013)
Stress	Pittman *et al*. (2012; Tan *et al*., 2009)
ATB therapy	Patel *et al*. (2012; Stoner *et al*., 2013)

Table 2. Cost of treating asthma bronchiale

Country	Direct costs ($)	Indirect costs (%)	Reference
Italy	1,396	62.5	Accordini *et al*. (2013)
	1,186	50	Anderson *et al*. (2012)
	1,432	15	Pakhale *et al*. (2011)
	800	-	Zehraeus *et al*. (2010)
Switzerland	2,200	-	Bedouch *et al*. (2012)
Spain	3,200	-	Bedouch *et al*. (2012)
	1,400	-	Edwards *et al*. (2011)
France	1,300	-	Edwards *et al*. (2011)
	750	-	Anderson *et al*. (2012)
Germany	1,500	-	Krstic (2011)
Denmark	1,000	67	Bedouch *et al*. (2012)
Turkey	1,400	20	Anderson *et al*. (2012)
Sweden	640	-	Anderson *et al*. (2012)
Netherlands	2,100	50	Negro *et al*. (2007)
USA	1,400	-	Tan *et al*. (2009)
Canada	400		Pasquale *et al*. (2012; Sadatsafavi *et al*., 2010)
South Korea	1,200-5,600	-	Kim *et al*. (2012)

Discussion

Asthma bronchiale represents a major health issue in industrialized countries. It is an insufficiently defined syndrome characterized by several phenotypes most probably with different etiology (Gudelj *et al*., 2012). The biggest problem is the fact that we still do not know the optimal standard for exact diagnosis and its relevant evaluation in epidemiological studies, so exact registration is difficult (Gudelj *et al*., 2012). Therefore, resulting value of AB registration differs based on methods used. The error in registered occurrence of AB can reach up to 20%. In industrialized countries, the costs of treatment AB reach 1-2% of total medical costs (Karmaus *et al*., 2013). However, is some countries can reach even up to 55% (Weissflog *et al*., 2001). Canadian study found 20.5% of const is attributable to inpatient care, 47.8% to outpatient care and 31.5% to medication (Sadatsafavi *et al*., 2016). In the United States, the asthma epidemics are also on the rise, from 3% in 1970 to 7.8% in 2008. The total costs per year are estimated to be $56 billions (Loftus and Wise, 2015).

To fully evaluate the cost of treatment in the Czech Republic is difficult. Direct costs are similar to other countries, but indirect costs influencing negative economical effects on individual, family and the whole society is impossible to calculate. Similarly, it is not possible to calculate costs of AB co-morbidity, as they are often treated by different departments or clinics by physicians trained in different specialties and the costs are not correlated with original diagnosis. It might be possible to gain complex information from the evidence of health care insurance, which in the Czech Republic covers almost the entire population. So far, we do not know any simple specific marker confirming AB diagnosis in all age groups. The basis of AB diagnosis is to focus attention on the detailed differential diagnosis of this disease (Negro *et al*., 2007). The main reasons for insufficient diagnosis of AB are probably general underestimation of occurrence of this disease, which is much higher than generally expected and with a steady increasing trend (Patel *et al*., 2012). An increase in AB prevalence for the next two decades is expected to reach 25%. The same trend can be expected in the Czech Republic, as we found more than a 10% increase in the 2000-2013 period (Fig. 3 and 4).

The number of factors involved in induction of AB is high and is constantly increasing with new studies. We evaluated many of these factors, but no significant correlation in their appearance with respect to geographical localization. Data of prevalence of AB in individual location and regions are most probably influenced with methods of registration of AB, particularly in a small location within main region of pediatricians. Evidence of the use of drugs for AB treatment might serve as a solid control mechanism for verification of AB diagnosis. Some studies evaluated registration and validation of diagnosis and found 89% sensitivity and 72% specificity of accurate diagnosis in the children population (Sadatsafavi *et al*., 2010; Subbarao *et al*., 2009). Regional prevalence of AB was also studied in Poland. This study showed differences in occurrence of AB among regions (Zalewska *et al*., 2013). Our current study has similar conclusions. A more direct analysis of importance of these findings is currently under way.

Total costs for AB treatment should be evaluated separately, as our estimates have only partial validity. We used minimal costs published in studies from European countries and used most of all costs of drugs and laboratory diagnostics, where there are minimal differences between European countries. The values of other factors can significantly differ, mostly based on

level of economical advancement and on different level of income among countries.

Conclusion

Ever increasing prevalence of AB will require increased attention not only in prevention, but also in diagnostics. There is strong need for early recognition of asthma and for adequate treatment. The failure in solving this problem will be associated with significant and to some extent even potentially crippling, the economic burden of health system.

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Author's Contributions

All authors equally contributed to this study.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issues were involved.

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