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Years of Life Lost Due to Bronchial Asthma in Poland Between 1999--2013

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ABSTRACT:

Objective: The aim of this study was to analyze the years of life lost due to asthma in Poland between 1999-2013, with the use of the SEYLL measure (*Standard Expected Years of Life Lost*).

Methods: The study was based on a dataset of 5 606 516 records gathered from death certificates of Polish residents from 1999-2013. The data on the deaths due to bronchial asthma and status asthmaticus (J45 and J46 according to ICD-10) were used for the analysis. The SEYLL, SEYLL_p (SEYLL per person) and SEYLL_d (SEYLL per death) were implemented to assess lost life years. The analysis of time trends was performed with the use of the joinpoint model.

Results: In 1999-2013, asthma and status asthmaticus were the cause of 11 380 deaths of Poles (0.20% of all deaths), resulting in 4.23 prematurely lost life years per 10 000 males and 3.22 years per 10 000 females. Over the analyzed years, the value of SEYLL decreased both for men and for women. A man who died due to asthma in the studied period, lost on average 19.12 years of life, and a woman 18.20 years.

Conclusions: The analysis of SEYLL indicated that premature mortality due to asthma is still a meaningful problem in the Polish population and a constant challenge for public health activities.

KEY WORDS:

bronchial asthma, diseases of the respiratory system, premature mortality, lost life years, SEYLL, potential measures, Poland

INTRODUCTION:

Diseases of the respiratory system, as the fourth leading cause of death in the Polish population, were responsible for 5.2% of all deaths of Poles in 2012 [1,2,3]. Among the highest contributors were influenza and pneumonia, and chronic lower respiratory diseases, i.e. bronchial asthma and chronic obstructive pulmonary disease (COPD). On average, in the European Union (EU), diseases of the respiratory system are the cause of about 8% of all deaths [4].

Globally, about 300 million people suffer from asthma. Moreover, in the report of *Global Initiative for Asthma* (GINA) from 2016 it was highlighted that the incidence of this disease is still growing, especially in children [5]. Likewise, the results of the *Global Burden of Disease* (GBD) revealed a worldwide increase in the morbidity of asthma by 9.5% between 2005 and 2015 [6]. This issue is also present in Poland. It is estimated that currently about 5 million Polish citizens are asthmatics. The results of the *Polish Multicenter Study of Epidemiology of Allergic Diseases* (PMSD) indicated that 5.4% of adult Poles and 8.6% of children aged 3-16 have asthma [7]. Comparably, the *International Study of Asthma and Allergies in Childhood* (ISAAC)- the biggest study on the prevalence of asthma in children worldwide, registered in its third phase that 5.9% Polish children aged 6-7 years and 5.2% aged 13-14 years suffer from asthma. Among the European Union countries, the highest prevalence was noted in Great Britain- it was 26.7% in children aged 6-7 years and between 24.3% and 25.5% in children aged 13-14 (dependently on the region), in Spain- ranging from 7.3% to 14.8% and 8.0-21.8%, respectively, and in Portugal- ranging from 4.9 to 14.2% and 12.2-15.6%, respectively. The lowest prevalence was noted in Northern and Eastern Europe, i.e. in Latvia- it was 0.9-2.6% in children aged 6-7 years and 1.6-3.3% in children aged 13-14, in Estonia- 4.1% and 4.8%, respectively, and in Croatia- 3.9% and 5.2%, respectively [8]. According to the *World Health Organization* (WHO), the highest morbidity rates for adults are observed in the north-west region of Europe: 20.6% of Swedish population aged 18-44 are asthmatics, 17.8% of the

United Kingdom and 15.4% of the Netherlands; and the lowest rates are observed in Eastern Europe: in Romania-1.6%, in Bulgaria- 2.0%, in Lithuania- 2.0% [9].

Asthma is a chronic condition and when not treated may lead to death. However, appropriate therapy providing complete control of the symptoms, facilitates normal everyday activities and prevents premature mortality of the patients [5].

To assess the epidemiological condition of the population due to this disease, it has become common to apply, besides conventional ratios, potential measures, i.e. measures that take into account the lifetime potential of the individuals in the population. In contrast to classically used death rates, potential measures do not only describe the intensity of mortality, but they also count lost life years caused by premature deaths. They enable the analysis of health, social and economic aspects of premature mortality [10]. Currently, one of the most commonly used potential measures is SEYLL (*Standard Expected Years of Life Lost*) [11].

The objective of this study was to assess the years of life lost due to asthma in the Polish population between 1999-2013, with the use of the SEYLL measure.

METHODS:

The study was based on a dataset of 5 606 516 records gathered from death certificates of Polish residents from 1999-2013, provided by the Central Statistical Office in Poland. The data on the deaths due to bronchial asthma and status asthmaticus were used for the analysis, i.e. coded as J45 and J46 according to the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* (ICD-10) [Fig.1].

Proportional and specific death ratios were calculated using the data on the number of inhabitants obtained from the Local Data Bank [12].

The mortality rates were standardized for age using the European population as a reference. The standardization procedure was performed with a direct method.

As a potential measure we applied the SEYLL indicator. It was calculated according to the method developed by Murray and Lopez [11]:

$$SEYLL = \sum_{\chi=0}^I d_{\chi} e_{\chi}^*$$

where:

e_{χ}^* is the average life expectancy for a particular age determined based on standard population;

d_{χ} is the number of deaths at age χ ;

χ is the age of death;

I is the oldest age in the population.

We also implemented $SEYLL_p$ (*Standard Expected Years of Life Lost per person*), which considers the size of the analyzed population N , in this study calculated per 10 000 inhabitants:

$$SEYLL_p = \frac{\sum_{\chi=0}^I d_{\chi} e_{\chi}^*}{N}$$

$SEYLL_d$ (*Standard Expected Years of Life Lost per deaths*), which describes the number of lost life years per one death, was calculated by dividing the years of life lost due to a particular cause by the number of deaths:

$$SEYLL_d = \frac{\sum_{\chi=0}^I d_{\chi} e_{\chi}^*}{\sum_{\chi=0}^I d_{\chi}}$$

To assess the measures mentioned above, we used the life tables published by the WHO in 2012 [13].

According to this source, the expected lifespan for both genders is 86.02 years. The values given in the table were not discounted over time or adjusted for age.

The analysis of the time trends was performed with the use of the joinpoint model. The software provided by the U.S. National Cancer Institute -- *Joinpoint Regression Program*, was used for this purpose [14].

Annual percentage changes (APC) in separate time intervals and average annual percentage changes (AAPC) in the entire studied period, with corresponding 95% confidence intervals (CI) were calculated for the standardised mortality rates and for SEYLL_p [15].

RESULTS:

Between 1999-2013 bronchial asthma and status asthmaticus caused 11 380 deaths of Poles, which accounted for 0.20% of deaths that occurred during that time in the Polish population. Bronchial asthma was the cause of 9 521 deaths (83.66% of deaths due to the analyzed diseases) and status asthmaticus was the cause of 1 859 deaths (16.34%). The number of deaths due to both diseases dropped over the studied period: 1 235 deaths due to asthma were reported in 1999 and only 469 deaths were in 2013, while 245 deaths due to status asthmaticus were reported in 1999 and only 53 deaths were in 2013. Besides this, a gradual decrease in the percentage share of status asthmaticus fatal cases among the total mortality cases due to the analyzed diseases was noted (16.55% in 1999 to 10.15% in 2013).

The death ratio between men and women was on average 1.17. A higher mortality in males due to asthma was observed between 1999-2008, while in the following years, i.e. 2009-2013, a higher mortality was noted in the group of women. [Tab.1].

Standardized mortality rates due to asthma, including status asthmaticus, decreased considerably by 2013 compared to 1999. In the group of men, this ratio declined from 10.16 per 100 000 males in 1999 to 1.82

in 2013, and in the group of women it decreased from 4.29 per 100 000 females to 1.62, respectively [Fig.2].

The analysis of the time trends of the standardized mortality rate for the general population revealed its dropping tendency over the studied period (AAPC = -9.0%, $P < 0.05$); a significant decrease was observed from 1999-2013 (APC = -11.9%, $P < 0.05$), and an irrelevant increase from 2010-2013 (APC = 2.8%, $P = \text{ns}$). In the group of men, throughout the entire analyzed time, a decreasing tendency persisted (AAPC = -12.6%, $P < 0.05$). In the group of women, the highest decline was observed from 1999-2002 (APC = -18.4%, $P < 0.05$), followed by a smaller decrease from 2002-2011 (APC = -7.3%, $P < 0.05$), and then an increasing trend from 2011-2013 (APC = 11.6%, $P = \text{ns}$). However, over all the analyzed time a decline of the values of the standardized mortality rate was observed (AAPC = -7.4%, $P < 0.05$) [Tab.2].

The analysis of the mortality rates due to bronchial asthma and status asthmaticus according to age indicated a meaningful connection to age; that is, the oldest groups contained the highest mortality rates. However, in 2013 compared to 1999 all the age groups showed a decrease in mortality rates due to the studied diseases [Fig.3.].

Between 1999-2013 bronchial asthma and status asthmaticus accounted for 212 792.76 lost life years: 117 388.79 years for men and 95 403.97 years for women. These figures translate to 3.71 prematurely lost life years per 10 000 inhabitants (SEYLL_p)- 4.23 years per 10 000 males and 3.22 years per 10 000 females. A Polish resident, who died in the analyzed time due to asthma, lost on average (SEYLL_d) 18.70 years of life- a man lost 19.12 years and a woman lost 18.20 years.

In 2013 compared to 1999, both the SEYLL and SEYLL_p decreased in the group of men and women. However, the SEYLL_d for men remained almost at the same level. The SEYLL_d for women from the beginning of the studied period was gradually decreasing, covering values from the highest, 19.78 in 1999, to the lowest, 15.31 in the last analyzed year [Tab.3].

In the general population, the SEYLL_p was steadily decreasing over the studied period (AAPC = -9.3%, $P < 0.05$). The tendency was particularly intense between 1999-2004 (APC = -14.9%, $P < 0.05$). In the following years, the falling trend persisted but with a lower intensity (APC = -6.0%, $P < 0.05$). In the group of men, a constant decline of SEYLL_p values was observed during the entire studied period (AAPC = -10.2%, $P < 0.05$). For women, a decreasing tendency was also observed (AAPC = -7.8%, $P < 0.05$), but its intensity was more pronounced between 1999 and 2004 (APC = -14.8%, $P < 0.05$) and less so in the following years (APC = 3.7%, $P < 0.05$) [Tab.4].

Deaths due to asthma, including status asthmaticus, accounted for 4.06% of all deaths due to respiratory diseases in the analyzed time. In the subsequent years, a decreasing share of the studied diseases was observed- from 8.26% in 1999 to 2.27% in 2013. A similar tendency was noted both in the group of men and women. Also, the percentage share of lost life years due to bronchial asthma and status asthmaticus out of the general number of SEYLL due to all diseases of the respiratory system decreased in the studied period from 9.78% in 1999 to 2.56% in 2013. On average, bronchial asthma and status asthmaticus were the cause of 4.76% of the total number of lost life years due to respiratory diseases.

Analyzing the percentage share of deaths due to bronchial asthma and status asthmaticus in the deaths due to all respiratory diseases, it was noted that it decreased in a greater extent for men than for women. Moreover, the percentage share of years of life lost due to bronchial asthma and status asthmaticus in each studied year was higher in the group of women than in men; in the first two years of the observation it even exceeded 10% [Tab.5].

DISCUSSION:

Diseases of the respiratory system are the fourth leading cause of death in the Polish population, following cardiovascular diseases, malignant neoplasms and external reasons [16,17,18]. In 1999, they were the cause of 4.70% of all deaths of Poles, and in 2013 they caused 5.92% of all deaths. The

prognosis suggests a further increase in mortality to occur in the following years, mostly associated with the increasing incidence of influenza and pneumonia [4,19]. On the other hand, the results of our study indicate a substantial improvement in the death rates due to asthma. Besides the decline in the number of deaths due to asthma from 1 480 in 1999 to 522 in 2013, the decreasing number associated with status asthmaticus draws some attention. Status asthmaticus as an exacerbation of the chronic inflammatory process in the bronchi, often complicated by the respiratory failure, is a considerable threat to life [20].

However, the analysis of the time trends of the standardized mortality rates due to asthma commands attention. After the initial decreasing trend of 11.92% yearly ($p < 0.05$) between 1999-2010, an increasing tendency of 2.76% ($p = ns$) was observed in the following years.

Additionally, Eurostat data indicated that the mortality due to asthma in the Polish population was still higher than the average for the European Union countries (EU-28). In 2013 in Poland, the standardized mortality rate due to asthma was 1.81 per 100 000 men and 1.61 per 100 000 women, while the average for the EU was 1.2 and 1.5, respectively. Among the EU-28, the highest death rates were observed in Estonia (5.6 per 100 000 males and 3.2 per 100 000 females) and in Cyprus (5.0 and 4.9, respectively); and the lowest rates were observed in Greece (0.1 and 0.1, respectively) and in Bulgaria (0.6 and 0.5, respectively) [4].

Still, mortality trends are particularly unfavorable in the group of women. In the last years of the observation, i.e. 2009-2013 asthma caused more deaths in the group of women than in men. Also, the standardized mortality rates trends analysis for women showed its increasing tendency between 2011 and 2013 ($APC = 11.6\%$, $P = ns$), while for men it was steadily decreasing over all the studied period ($APC = -12.6\%$, $P < 0.05$). Besides, in 2012-2013 the number of lost life years due to asthma in the group of women started to exceed the values for men. These results are consistent with other studies [21,22,23], whose authors suggest that they can be explained by the predominance of women in older asthmatic age

groups and by the gender differences in tobacco use. Cigarette smoking seems not to be the case in the Polish population- in 2014 the values of the age-standardized prevalence rates were 31.3% for men and 25.2% for women [24,25]. Since there is no certain data on this topic, further investigation is essential to explain the causes of sex differences.

The assessment of the death rates of Poles due to asthma according to age indicated improvement in each age group over the analyzed years. This is mostly the result of early detection of the disease, as well as an increase in the effectiveness of the current treatment. GINA is responsible for a large share of the worldwide promotion of effective methods of diagnosis and therapy of asthma [5], but Poland has also created a number of local initiatives [26,27,28]. However, the prevalence of asthma, despite many studies on its etiology, is still increasing [29]. Currently, the development of asthma is believed to be strongly associated with genetic and environmental factors. Simultaneously, it is emphasized that these relations are very complex and still unclear [30,31,32].

Comparing epidemiological situations between countries using only conventional measures of health status seems to no longer be sufficient [30,33,34,35]. For this purpose, the GBD initiated by Murray and Lopez, promotes the use of DALY (*Disability-adjusted Life Years*), which consists of YLLs (*Years of Life Lost*) and YLDs (*Years of Life with Disability*) [10,36].

To assess the number of YLLs due to premature deaths, it is also possible to use other measures than SEYLL, like PEYLL (*Period of Expected Years of Life Lost*) or PYLL (*Potential Years of Life Lost*), but their application in comparing populations is limited. PEYLL uses local data to determine referential values of life expectancy, making it not only impossible to compare the populations with different lifespans, but also to assess the changes in time within the same population. PYLL, instead, chooses a limit of life expectancy at an age between 60 and 85 (mostly 70), so it ignores the advantages that come from the initiatives directed towards the oldest members of the population [17,37,38,39].

Analyzing the values of DALY for particular diseases on a global scale, asthma ranked 25th in 2015, 26th in 2005 and 23rd in 1990. Regarding the number of YLLs, asthma ranked 37th in 2015, which was a significant improvement compared to 2005, when it was 32nd and to 1990, when it was 26th [40]. Also, the results of our study indicate that the number of YLLs due to asthma in Poland decreased over the analyzed years (from 29 337.88 lost life years in 1999 to 8 946.98 years in 2013).

In our study the number of deaths and YLLs due to asthma was compared with the number of deaths and YLLs due to all respiratory diseases. Over the analyzed time, the percentage share of deaths and YLLs due to asthma had a declining tendency for both sexes. However, it needs highlighting that over all the studied period the percentage share of YLLs was higher than the percentage share of deaths among all respiratory diseases. This indicates that premature mortality due to asthma is still a present problem in the Polish population, and it ascribes the need to continue the interventions directed towards further reduction of this phenomenon.

The database restricted to only primary causes of deaths, without comprising the co-existing diseases, is among this study's limitations. Besides, it should be noted that during coding the causes of deaths according to ICD-10, several mistakes might have occurred. This problem particularly concerns the elderly, who are characterized by the phenomenon of co-morbidity. However, these objections are reserved to the majority of studies based on death data [26].

CONCLUSIONS:

The assessment of the epidemiological situation using potential measures provide meaningful data on the premature mortality. The results of the study revealed that in Poland between 1999-2013 asthma was the cause of 4.23 years of life lost per 10 000 men and 3.22 years of life lost per 10 000 women. Each death due to asthma that occurred in the analyzed time in the Polish population contributed to the loss of 19.12 years of life for a man and 18.20 years of life for a woman. Particularly the obtained values of SEYLL_d

justify that asthma is a substantial problem in the health status of Poles and a constant challenge to public health activities.

DECLARATION OF INTEREST STATEMENT:

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

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Tab.1. Deaths due to bronchial asthma and status asthmaticus in the Polish population between 1999-2013 according to sex

Year	Men			Women			Death ratio between men and women
	Bronchial asthma	Status asthmaticus	Total	Bronchial asthma	Status asthmaticus	Total	
1999	756 (86.80%)	115 (13.20%)	871	479 (78.65%)	130 (21.35%)	609	1.43
2000	666 (84.52%)	122 (15.48%)	788	494 (82.06%)	108 (17.94%)	602	1.31
2001	492 (84.10%)	93 (15.90%)	585	393 (82.05%)	86 (17.95%)	479	1.22
2002	470 (81.60%)	106 (18.40%)	576	288 (77.63%)	83 (22.37%)	371	1.55
2003	389 (82.94%)	80 (17.06%)	469	298 (79.68%)	76 (20.32%)	374	1.25
2004	345 (81.75%)	77 (18.25%)	422	268 (83.23%)	54 (16.77%)	322	1.31
2005	314 (82.20%)	68 (17.80%)	382	241 (76.75%)	73 (23.25%)	314	1.22
2006	275 (82.58%)	58 (17.42%)	333	236 (80.27%)	58 (19.73%)	294	1.13
2007	293 (87.20%)	43 (12.80%)	336	235 (79.93%)	59 (20.07%)	294	1.14
2008	281 (84.89%)	50 (15.11%)	331	241 (85.46%)	41 (14.54%)	282	1.17
2009	211 (86.83%)	32 (13.17%)	243	210 (82.35%)	45 (17.65%)	255	0.95
2010	168 (89.36%)	20 (10.64%)	188	205 (87.61%)	29 (12.39%)	234	0.80
2011	179 (88.18%)	24 (11.82%)	203	218 (87.20%)	32 (12.80%)	250	0.81
2012	180 (90.91%)	18 (9.09%)	198	227 (89.72%)	26 (10.28%)	253	0.78
2013	192 (90.14%)	21 (9.86%)	213	277 (89.64%)	32 (10.36%)	309	0.69
Total	5 211 (84.90%)	927 (15.10%)	6 138	4 310 (82.22%)	932 (17.78%)	5 242	1.17

Tab.2. Time trends for the standardized mortality rates due to bronchial asthma and status asthmaticus, calculated per 100 000 inhabitants, in Poland between 1999-2013 according to sex using the joinpoint analysis

Sex	Time period	APC [%]	95% CI		AAPC [%]	95% CI	
Men	1999-2013	-12.6*	-13.9	-11.3	-12.6*	-13.9	-11.3
Women	1999-2002	-18.4*	-24.5	-11.8	-7.4*	-9.7	-5.1
	2002-2011	-7.3*	-8.9	-5.8			
	2011-2013	11.6	-4.5	30.4			
Total	1999-2010	-11.9*	-13.4	-10.4	-9.0*	-11.3	-6.5
	2010-2013	2.8	-9.3	16.4			

* statistically significant changes ($p < 0.05$)

APC- annual percentage changes

AAPC- average annual percentage changes

CI- confidential intervals

Tab.3. Years of life lost due to bronchial asthma and status asthmaticus in Poland between 1999-2013 according to sex

Year	Men			Women		
	SEYLL	SEYLL _p	SEYLL _d	SEYLL	SEYLL _p	SEYLL _d
1999	17 294.33	9.32	19.86	12 043.55	6.12	19.78
2000	15 263.91	8.23	19.37	11 773.36	5.98	19.56
2001	10 996.12	5.93	18.80	9 176.66	4.66	19.16
2002	11 103.06	6.00	19.28	7 196.49	3.66	19.40
2003	8 527.23	4.62	18.18	6 724.14	3.40	17.98
2004	7 773.18	4.21	18.42	5 998.80	3.05	18.63
2005	7 162.82	3.88	18.75	5 820.11	2.95	18.54
2006	6 212.06	3.37	18.65	4 945.31	2.51	16.82
2007	6 281.29	3.41	18.69	5 000.53	2.54	17.01
2008	6 352.48	3.45	19.19	5 068.31	2.57	17.97
2009	4 638.91	2.52	19.09	4 789.13	2.43	18.78
2010	3 674.80	1.97	19.55	3 841.91	1.93	16.42
2011	4 152.89	2.23	20.46	4 087.69	2.06	16.35
2012	3 740.77	2.01	18.89	4 205.94	2.12	16.62
2013	4 214.94	2.26	19.79	4 732.04	2.38	15.31
Total	117 388.79	4.23	19.12	95 403.97	3.22	18.20

SEYLL- Standard Expected Years of Life Lost

SEYLL_p- Standard Expected Years of Life Lost per person (per 10 000 inhabitants)

SEYLL_d- Standard Expected Years of Life Lost per death

Tab.4. Time trends for SEYLL_p due to bronchial asthma and status asthmaticus, calculated per 10 000 inhabitants, in Poland between 1999-2013 according to sex using the joinpoint analysis

Sex	Time period	APC [%]	95% CI		AAPC [%]	95% CI	
Men	1999-2013	-10.2*	-11.7	-8.7	-10.2*	-11.7	-8.7
Women	1999-2004	-14.8*	-20.1	-9.2	-7.8*	-10.1	-5.5
	2004-2013	-3.7*	-6.2	-1.2			
Total	1999-2004	-14.9*	-20.5	-8.9	-9.3*	-11.7	-6.9
	2004-2013	-6.0*	-8.6	3.4			

*statistically significant changes (p<0.05)

APC- annual percentage changes

AAPC- average annual percentage changes

CI- confidential intervals

Tab.5. Percentage share of deaths and life years lost due to bronchial asthma and status asthmaticus in the number of deaths and lost life years caused by all diseases of the respiratory system in Poland between 1999-2013 according to sex

Year	Men		Women		Total	
	Deaths [%]	SEYLL [%]	Deaths [%]	SEYLL [%]	Deaths [%]	SEYLL [%]
1999	8.35	8.94	8.12	11.29	8.26	9.78
2000	7.51	8.02	7.70	10.69	7.59	9.00
2001	6.30	6.54	7.40	9.94	6.75	7.74
2002	6.17	6.70	5.99	8.39	6.10	7.27
2003	4.60	4.78	5.23	6.93	4.86	5.54
2004	4.15	4.33	4.81	6.56	4.41	5.09
2005	3.45	3.74	4.20	5.80	3.75	4.45
2006	2.99	3.18	4.00	4.99	3.40	3.79
2007	2.85	3.01	3.85	4.82	3.24	3.61
2008	2.86	3.13	3.65	4.83	3.18	3.71
2009	1.99	2.16	3.02	4.11	2.41	2.85
2010	1.64	1.84	2.98	3.60	2.18	2.45
2011	1.71	2.02	3.08	3.62	2.27	2.59
2012	1.69	1.92	3.00	3.83	2.24	2.61
2013	1.63	1.91	3.14	3.68	2.27	2.56
Total	3.70	4.04	4,57	6.09	4.06	4.76

SEYLL- Standard Expected Years of Life Lost





