The analysis of the level and trends of potential years of life lost due to diabetes in Poland in the years 2002-2013

Papaj D.[1,A-D], Beck M.[2,C-F*], Papaj E.[1B-E]

1. A graduate of the Faculty of Health Sciences, Medical University of Bialystok, Białystok, Poland
2. Department of Integrated Medical Care, Faculty of Health Sciences, Medical University of Bialystok, Białystok, Poland

---

A- Conception and study design; **B** - Collection of data; **C** - Data analysis; **D** - Writing the paper; **E**- Review article; **F** - Approval of the final version of the article

---

ABSTRACT

Introduction: The industrial and socio-economic development is the direct cause of changes in major health threats in highly developed societies. Diabetes is a civilization disease and it depends on the impaired action of insulin. Together with its complications, it is a significant cause of deaths all over the world.
Purpose: To assess the level and trends of potential years of life lost (PYLL) due to diabetes in Poland in the years 2002-2013. For specific purposes, it is necessary to assess the PYLL level and the dynamics of PYLL rates due to diabetes and comparison with all causes of death.
Materials and Methods: The research material consists of data from generally available databases from the Polish Statistical Office. Potentially lost years of life were calculated using the method proposed by J-M Romeder. Premature deaths have been defined as deaths occurring before the age of 70. Trends in PYLL coefficients were generated by the computer program Joinpoint Regression Programme. **Results:** The results of the conducted analysis unambiguously indicate the increase in the PYLL ratio due to diabetes was observed in both the general population and the male population. The higher rate of PYLL growth and its much higher level in the male population, compared to the female population, point out to the fact that men die much younger because of diabetes. The dynamics of the PYLL coefficient trends connected with all causes of death indicate the reduction of premature mortality.
Conclusions: The results obtained indicate the need for social intervention in the prevention of diabetes.
Keywords: Diabetes, potential years of life lost, PYLL, trends.

DOI

* **Corresponding author**:
Mariusz Beck
Department of Integrated Medical Care, Medical University of Bialystok
Marii Skłodowskiej-Curie 7, 15-069 Białystok, Poland
Tel: +48-517-133-223; e-mail: mariuszbeck@gmail.com

Received: 15.02.2019
Accepted: 23.03.2019
Progress in Health Sciences
Vol. 9(1) 2019 pp 51-59

INTRODUCTION

The industrial and socio-economic development is the direct cause of changes in major health threats in the highly developed societies. It results in changes in the incidence of disease entities and in the structure of the causes of deaths, and therefore also in the structure of health needs, both individual and collective. This applies to four major groups of diseases and its accompanying changes: infectious diseases, accidents and injuries, civilization diseases, new health threats. The process of these changes can be called the epidemiological transformation [1-3].

According to the World Health Organization (WHO), diabetes is a set of metabolic diseases characterized by hyperglycaemia resulting from a defect in the secretion or action of insulin. Chronic hyperglycemia in diabetes is associated with damage, dysfunction and failure of various organs, especially eyes, kidneys, nerves, heart and blood vessels [4]. Type 1 diabetes mellitus is caused by total destruction of pancreatic β cells in an autoimmune or idiopathic process and accounts for about 10% of all diabetes cases, whereas 85-90% of those with this type are people under the age of 30. Type 2 diabetes is the result of the acquisition of insulin resistance by the body's tissues combined with impaired secretory function of β-cell pancreatic islets, and this type of diabetes most often occurs among middle-aged and elderly people. According to the data of the Organization for Economic Cooperation and Development (OECD), in 2014, 380-422 million people around the world suffered from diabetes. WHO reports that in 2012, 1.5 million people died from diabetes and about 43% of these deaths occurred before the age of 70. The OECD estimates that by 2035 the number of patients will increase to 600 million. In Poland, diabetes affects up to 5% of the population, or about 2 million people, while about 4 million people can be diagnosed with diabetes risk symptoms.

In Poland, from 2002 to 2013 about 6,000 people died due to diabetes each year. Unfortunately, diabetes is not diagnosed in a significant proportion of patients, so the figures given on morbidity and mortality are only estimates [4-8].

MATERIALS AND METHODS

As research material the publicly available databases of Statistics Poland (GUS) were used, containing information on the population sizeof Poland in five-year age groups according to gender in the years 2002-2013, and publicly available GUS databases containing information on the number of deaths by sex, age in five-year groups and causes of death in ICD10 classification in 2002-1013.

The study included deaths due to all types of diabetes and its complications (according to the ICD-10 classification, these are units from the E10-E14 range, 6205 cases), as well as data on deaths due to all causes (374,488) [9,10]. The crud rate of potential years of life lost (PYLL) was used to analyze the level of premature mortality. PYLL were calculated according to the method proposed by J-M Romeder [11]. Premature deaths have been defined as deaths occurring before the age of 70.

PYLL according to the J-M Romeder method:

$$PYLL = \sum_{i=1}^{70} a_1 d_1$$

a- Average number of remaining years of life in the age group (for example: in the 15-19 age group it is 52,5)
d- The number of deaths in the age group

The PYLL is a negative epidemiological indicator that allows to assess the health status of the population and social losses due to premature deaths. The assessment of trends in changes of this indicator allows to determine the effectiveness of health care interventions undertaken to date, which were aimed at reducing premature mortality due to a given disease. PYLL rates due to diabetes and due to all causes of deaths from 2002-2013, according to gender, are demonstrated in the summary table and subjected to statistical analysis using the Joinpoint Regression Programme [12].

RESULTS

Table 1 shows the absolute number of deaths and PYLL rate due to diabetes and due to all causes in 2002-2013, and their average values in this time interval. The absolute number of deaths was given for the examined age range 0-69 years and for the 0-85 + interval. Analyzing the data in the table, an increase in the number of premature deaths due to diabetes can be noticed. The increase in PYLL coefficients occurred in both groups of genders throughout the entire period of time observed. The numbers of premature deaths and PYLL rates due to all causes of death at the same time are clearly decreasing.

In the studied period of time, no statistically significant changes in PYLL were observed among women. In male population in the described period of time, two points of change in the dynamics of the trend have been distinguished, which divide it into three compartments with different values of the average annual percentage change in PYLL.

Table 1. Number of deaths due to diabetes and PYLL in Poland in 2002-2013

Year	Diabetes			All causes		
	Number of deaths 0-85+	Number of deaths 0-69	PYLL rate[a]	Number of deaths 0-85+	Number of deaths 0-69	PYLL rate[a]
2002	5126	1773	54.3	359486	144709	6694.9
2003	5226	1747	56.3	365230	143444	6561.2
2004	5078	1752	56.5	363522	144538	6655.6
2005	5447	1767	63	368285	145159	7274.1
2006	6014	1969	69.6	369686	146276	7173.9
2007	6359	2047	67.7	377226	147727	6809.3
2008	6599	2026	67.6	379399	146569	6729.8
2009	6761	2067	71.3	384940	145714	7041.5
2010	6512	2004	66.6	378478	141624	6192.6
2011	6766	1993	63.2	375501	141386	6091.2
2012	7129	2156	67.1	384788	143977	5995
2013	7441	2273	70.5	387312	143775	5787.6
2002-2013 Average	6205	1965	64.5	374488	144575	6584

a – PYLL rate per 100 000 population of people aged 0-69

Table 2. Mid-term percentage change in PYLL trends due to diabetes in Poland in years 2002-2013 – woman and man

Annual Percent Change (APC)								
Cohort	Segment	Lower Endpoint	Upper Endpoint	APC	Lower Cl	Upper CL	Test Statistic	P-value
Man	1	2002	2008	6,4^	4,2	8,7	8,3	0
Man	2	2008	2011	-4,9	-15,9	7,6	-1,1	0,3
Man	3	2011	2013	7,8	-4,7	22	1,7	0,2
Woman	1	2002	1013	0,9	0	1,8	2,2	0,1
^ The Annual Percent Change (APC) is significantly different from zero at alpha = 0,05								
Average Annual Percent Change (AAPC)								
Cohort	Range	Lower Endpoint	Upper Endpoint	AAPC	Lower Cl	Upper CL	Test Statistic	P-value
Man	Full Range	2002	2013	3,5^	0,4	6,6	2,2	0
Woman	Full Range	2002	2013	0,9	0	1,8	2,2	0,1
^The Average Annual Percent Change (AAPC) is significantly different from zero at alpha = 0,05. Parametric method used								
Average Annual Percent Change (AAPC) Comparison								
Cohort	Range	Lower Endpoint	Upper Endpoint	AAPC Difference	Lower Cl	Upper CL	Test Statistic	P-value
Comparison	Full Range	2002	2013	2,6^	-0,6	5,8	1,6	0,1
^The Average Annual Percent Change (AAPC) is significantly different from zero at alpha = 0,05								

From 2002 to 2008, the average annual percentage increase in PYLL in men was 6.4% and was statistically significant ($p < 0.05$). In 2008-2011 and 2011-2013, the average annual percentage change in PYLL in men was not statistically significant. In the entire analyzed period of time (2002-2013), the average annual percentage increase in PYLL in men was 3.5% and was statistically

significant (p <0.05). In the whole studied population, in the described period of time (2002-2013), one point of change in the dynamics of the trend has been distinguished, which divides it into two compartments with different values of the average annual percentage change in PYLL. From 2002 to 2006, the average annual percentage increase in PYLL in the entire population was 6.4% and was statistically significant (p <0.05). In the years 2006-2013, there was no change in the dynamics of the PYLL rate trend in the entire population. In the entire analyzed period of time (2002-2013), the average annual percentage increase in PYLL in the entire population was 2.3% and was statistically significant (p <0.05). In the analyzed period of time PYLL trend were divided into two parts due to all causes of deaths among women and men, through one point of change in the dynamics of the trend in 2008. In 2002-2008, the average annual percentage increase in PYLL in the group of men was 1% and was statistically significant (p <0.05). In 2008-2013, the average annual percentage change in the PYLL rate in men amounted to -3.9% and was statistically significant (p <0.05). In the entire period, the average annual PYLL change was -1,3% and was statistically significant (p <0.05).

In the population of women in 2002-2008 no statistically significant change in the dynamics of the PYLL rate trend was observed. In 2008-2013, the average annual percentage change in PYLL in women was -2.7% and was statistically significant (p <0.05). In the entire analyzed period, the average annual PYLL change was -1,3% and was statistically significant (p <0.05

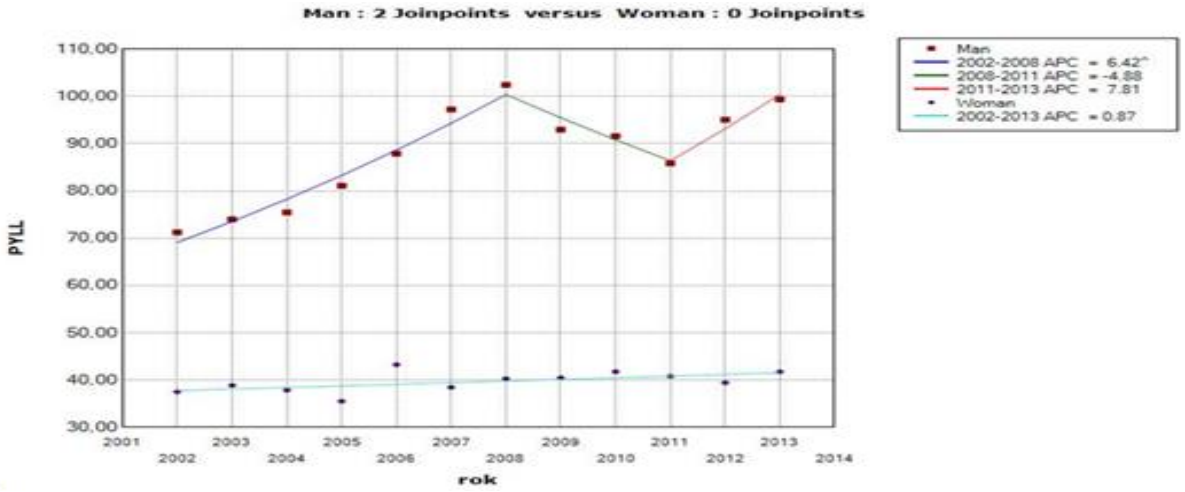

Figure 1. Mid-term percentage changes in PYLL trends due to diabetes in Poland in years 2002-2013 - women and men

Table 3. Mid-term percentage change in PYLL trends due to diabetes in Poland in years 2002-2013 – the entire population

Estimated Joinpoints								
Cohort	Joinpoint	Estimate	Lower Cl	Upper CL				
All	1	2006	2004	2009				
Annual Percent Change (APC)								
Cohort	Segment	Lower Endpoint	Upper Endpoint	APC	Lower Cl	Upper CL	Test Statistic	P-value
All	1	2002	2006	6,4^	1,9	11	3,4	0
All	2	2006	2013	0	-1,8	1,8	0	1
^ The Annual Percent Change (APC) is significantly different from zero at alpha = 0,05								
Average Annual Percent Change (AAPC)								
Cohort	Range	Lower Endpoint	Upper Endpoint	AAPC	Lower Cl	Upper CL	Test Statistic	P-value
All	Full Range	202	2013	2,3^	0,6	3,9	2,8	0
^The Average Annual Percent Change (AAPC) is significantly different from zero at alpha = 0,05. Parametric method used								

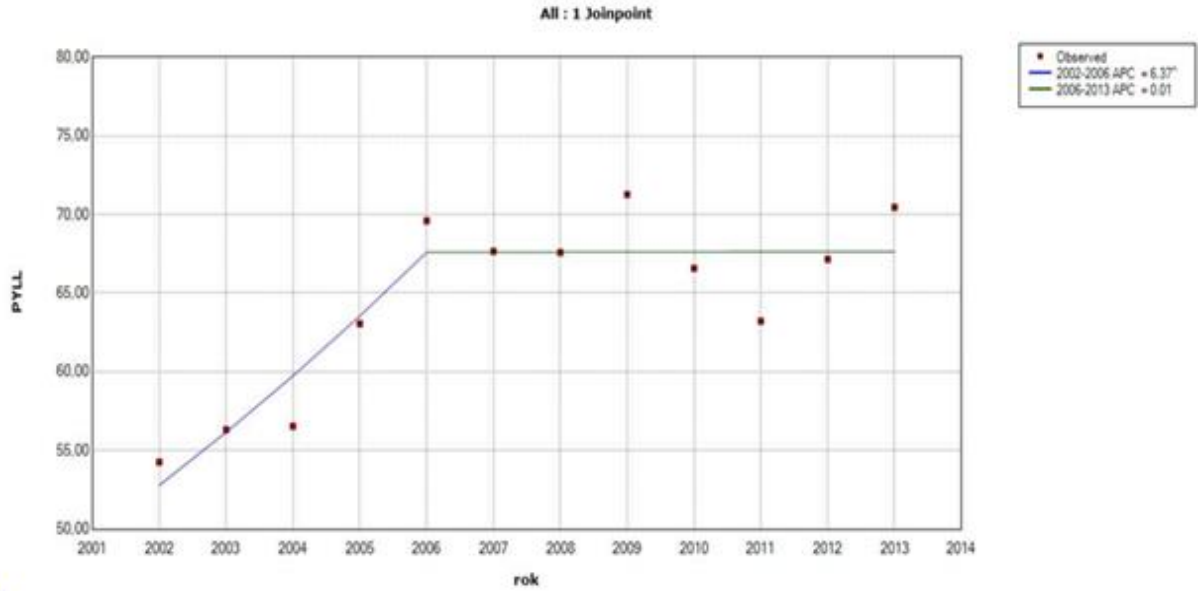

Figure 2. Mid-term percentage changes in PYLL trends due to diabetes in Poland in the years 2002-2013 - the entire population

Table 4. Mid-term percentage change in PYLL trends due all causes of death in Poland in years 2002-2013 – woman and man

Estimated Joinpoints								
Cohort	Joinpoint	Estimate	Lower Cl	Upper CL				
Man	1	2008	2007	2009				
Woman	1	2008	2006	2010				
Annual Percent Change (APC)								
Cohort	Segment	Lower Endpoint	Upper Endpoint	APC	Lower Cl	Upper CL	Test Statistic	P-value
Man	1	2002	2008	1^	0,4	1,6	3,8	0
Man	2	2008	2013	-3,9^	-4,7	-3,1	-12	0
Woman	1	2002	2008	-0,1	-1,1	0,8	-0,3	0,7
Woman	2	2008	2013	-2,7^	-3,9	-1,5	-5,3	0
^ The Annual Percent Change (APC) is significantly different from zero at alpha = 0,05								
Average Annual Percent Change (AAPC)								
Cohort	Range	Lower Endpoint	Upper Endpoint	AAPC	Lower Cl	Upper CL	Test Statistic	P-value
Man	Full Range	2002	2013	-1,3^	-1,7	-0,9	-6,3	0
Woman	Full Range	2002	2013	-1,3^	-1,9	-0,7	-4,2	0
^The Average Annual Percent Change (AAPC) is significantly different from zero at alpha = 0,05. Parametric method used								
Average Annual Percent Change (AAPC) Comparison								
Cohort	Range	Lower Endpoint	Upper Endpoint	AAPC Difference	Lower Cl	Upper CL	Test Statistic	P-value
Comparison	Full Range	2002	2013	0	-0,7	0,8	0,1	0,9
^The Average Annual Percent Change (AAPC) is significantly different from zero at alpha = 0,05								

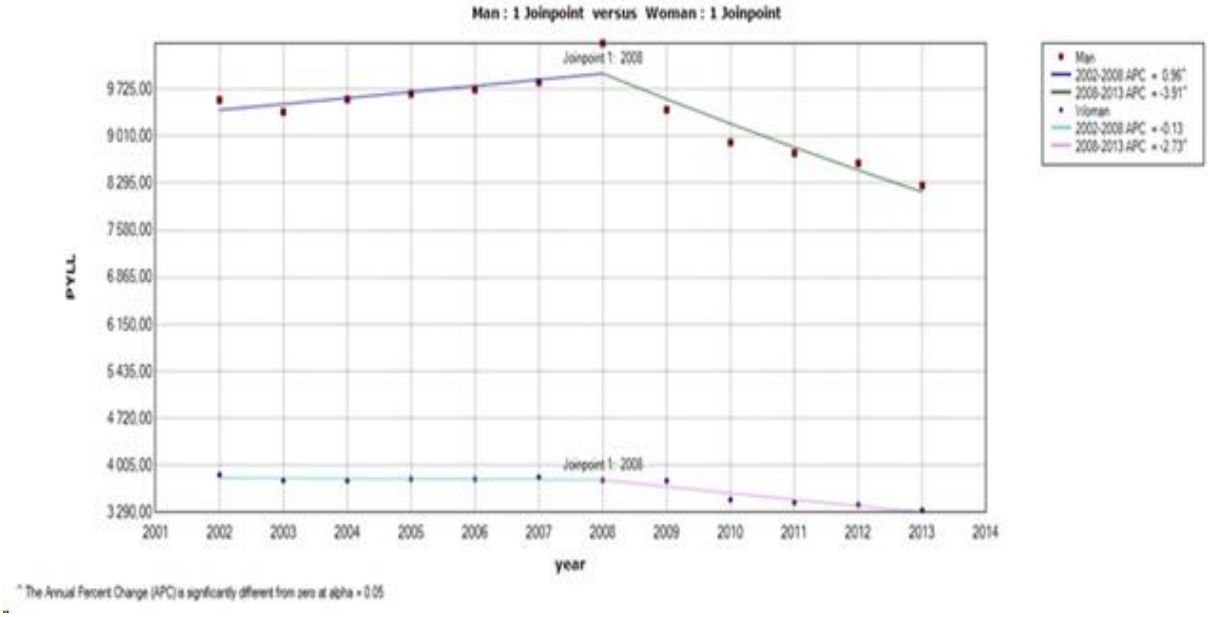

Figure 3. Medium-term percentage changes in PYLL trends due to all causes of death in Poland in 2002-2013 - women and men

In the entire analyzed population, in the described time interval, one point of change in the dynamics of the trend (in 2006) has been distinguished, which divides it into two compartments with different values of the average annual percentage change in PYLL. In the years 2002-2006 no statistically significant change in the dynamics of the PYLL rate trend was observed. In 2006-2013, the average annual percentage change in PYLL in the entire population was -3% and was statistically significant ($p < 0.05$). In the entire analyzed period of time the average annual change in the PYLL coefficient was not statistically significant.

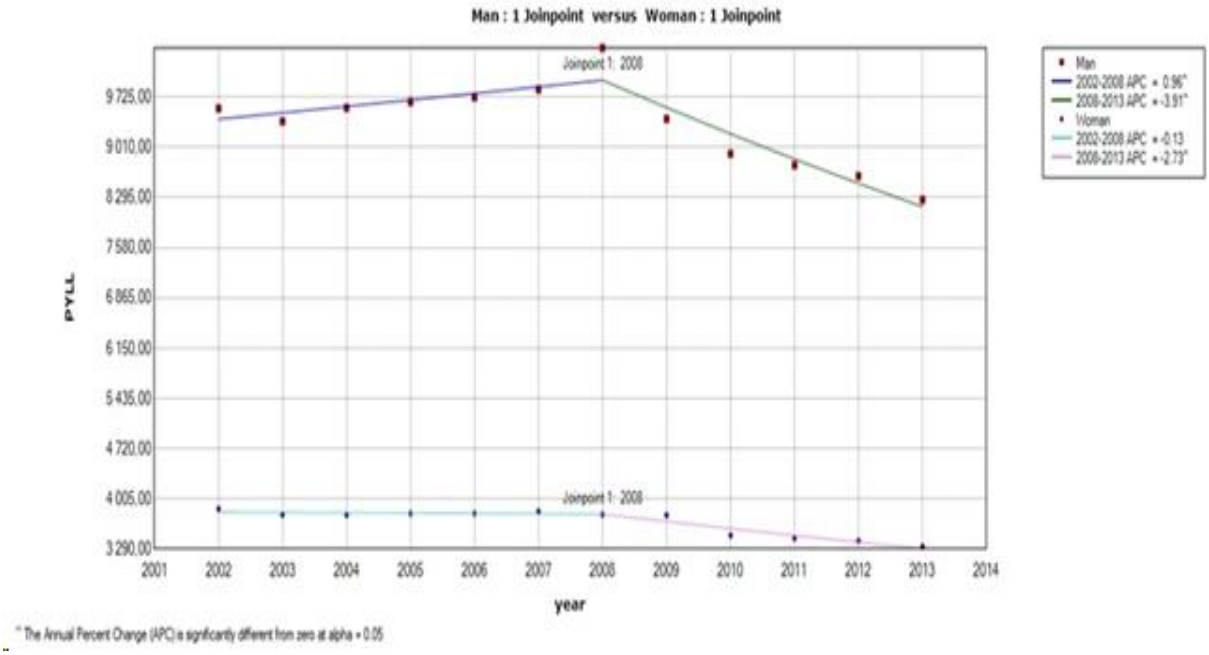

Figure 4. Medium-term percentage changes in PYLL trends due to all causes of death in Poland in 2002-2013 - the entire population

DISCUSSION

The industrial and socio-economic development is the direct cause of changes in major health threats in the highly developed societies. It causes changes in the incidence of disease entities and changes in the structure of causes of death. This highlights the changes in the structure of health needs, both individual and collective. Infectious diseases is the oldest and largest historical epidemiology problem that has accompanied humanity from the very beginning. Thanks to the development of microbiology and the discovery of ways in which infectious diseases are transmitted, the science of hygiene, preventive vaccinations and antibiotics was introduced, which led to a significant reduction of their share in the structure of causes of deaths. Accidents and injuries prevailed for some time in the 20th century in the structure of causes of death in the developed countries. Traffic accidents and other serious injuries were characterized by high mortality due to the lack of rescue system and the mediocre development of surgery in those times. Civilization diseases have changed over time, and the prolonged life expectancy, industrial development, rapid social development, lifestyle and diet changes have led to the development of epidemics of civilization diseases, such as cancer, cardiovascular disease, diabetes and chronic obstructive pulmonary disease, being the biggest public health challenge. New health threats include diseases such as AIDS, SARS or hemorrhagic fever, as well as drug addictions and legal highs that pose a new and enormous challenge for healthcare professionals around the world. This process can be called an epidemiological transformation [1-3].

Type 1 diabetes (insulin-dependent) is caused by the complete destruction of β-cell pancreatic islets in an autoimmune or idiopathic process. It results in a lack of insulin production, which causes sudden and high increases in blood glucose after a meal. The onset of the disease is usually sudden, characterized by increased diuresis and thirst, weakness, drowsiness and even the occurrence of ketone coma. Type 1 diabetes mellitus accounts for about 10% of all cases for diabetes, while 85-90% of those with this type are people under the age of 30. Type 2 diabetes (non-insulin dependent) is the result of the acquisition of insulin resistance by the body's tissues combined with the impaired secretory function of β-cell pancreatic islets. Acquired insulin resistance is strongly associated with lifestyle, diet and obesity. Excessive visceral fat and recurrent hyperglycaemic events result in impaired of insulin functioning. Most people in middle and elderly age suffer from this type of diabetes. In 2014, 380 - 422 million people suffered from diabetes in the world, while in 2012, 1.5 million people died from diabetes, and about 43% of those deaths occurred before the age of 70. It is estimated, that by 2035 the number of patients will increase to 600 million. In Poland around 2 million people suffer from diabetes, while about 4 million people can be diagnosed with diabetes risk symptoms. In Poland on average about 6,000 people died due to diabetes in years 2002-2013. Unfortunately, diabetes is not diagnosed in a significant proportion of patients, so data about morbidity and mortality is only an estimate [4-8].

The fact that the PYLL rate increases due to diabetes, both in the general population and in the male population, is worrying. Higher rate of PYLL increase and its much higher level in the male population compared to the female population points out to the fact that men die much younger because of diabetes. The dynamics of the PYLL trends due to all causes of death indicates a reduction in premature mortality. Rising values of PYLL rate due to diabetes, with simultaneous decrease in the PYLL due to all causes of death, indicate a lack of activity in the field of primary and secondary prevention of diabetes in Poland, at least over the past several decades. Currently there is no effective and clinically practiced method of preventing type 1 diabetes in the general population as well as among people in the high risk group [13]. In order to prevent morbidity and premature deaths caused by type 2 diabetes, it is necessary to monitor people at risk (obesity, sedentary lifestyle, poor diet, family history) in screening programs. Numerous scientific studies prove the high effectiveness of lifestyle changes and diet in reducing the risk of developing type 2 diabetes. Most of the available research on lifestyle changes describes: regular physical activity, weight reduction, decreasing the amounts of simple sugars in diet, introduction of regular meals, avoidance of alcohol and quitting smoking. These studies show that due to behavioral changes in people at high risk of type 2 diabetes, the risk was reduced by 31-69% [14-16] during the course of the study. Studies have shown that three years after the end of the study, the risk reduction was maintained among the study group at the level of 36% (originally 63-69%) [17]. Another study has shown a reduction in the risk of disease in the research group after 10 years from the end of the intervention by as much as 34% (originally 58%) [18]. The analysis of costs and intervention results prove that the introduction of programs for the early prevention of type 2 diabetes for people with a specific risk of disease is economically beneficial [14]. An obesity epidemic, which is one of risk factors for type 2 diabetes, is undoubtedly the direct cause of deteriorating epidemiological indicators of diabetes. Obesity is a global problem, but it mainly affects the industrialized countries [19]. Currently, the number of obese people in the world has doubled since 1980. In 2014, more than 1.9 billion (39%) of adults in the world have been overweight, with over 600 million (13%) being obese [20]. Studies also indicate

deficiencies in patient education regarding risk factors, course of the disease, treatment and possible consequences of complications. This has a negative effect on the prevention and treatment of diabetes. Among both healthy and sick people in Poland, knowledge on diabetes is poor [21,22]. An important problem affecting the mortality rate due to diabetes, is questionable accuracy of data on the morbidity and the number of deaths due to this disease. It is estimated that in Poland, almost half of cases of diabetes are not diagnosed and treated. The erroneously filled out death certificates and failure to place the accurate underlying cause on them also misrepresents statistical data. This leads to distortions in the research of the health needs of society and inappropriate response from healthcare institutions [23].

CONCLUSIONS

The results of the conducted analysis unambiguously indicate the lack of PYLL reduction due to diabetes in the Polish population. The PYLL rate increases due to diabetes, both in the general population as well as in the male population, which is a worrying fact. The greater PYLL growth rate and its much higher level in the male population, as compared to the female population, point out to the fact that that men die from diabetes much younger. The dynamics of the PYLL trends due to all causes of death indicates a reduction in premature mortality. Rising values of PYLL rates due to diabetes, with simultaneous decrease of the PYLL due to all causes of death, indicate a lack of primary actions and secondary prevention of diabetes in Poland, at least over the last several decades.

Conflicts of interest

All contributing authors declare no conflicts of interest.

REFERENCES

1. Gębska-Kuczerowska A, Miller M. Analiza sytuacji epidemiologicznej w Polsce w zakresie głównych problemów zdrowotnych. Post Nauk Med. 2009;4:240-55. (Polish)
2. Beaglehole R, Bonita R, Kjellström T, tłum: Szeszenia-Dąbrowska N. Podstawy epidemiologii. Instytut Medycyny Pracy; Łódź, 2002. (Polish)
3. Jabłoński L. Epidemiologia – podręcznik dla lekarzy i studentów. Folium; Lublin, 1996. (Polish).
4. Sieradzki J. Cukrzyca i zespół metaboliczny [w:] Interna Szczeklika, Podręcznik chorób wewnętrznych. Medycyna Praktyczna; Kraków, 2012, p. 1322-42. (Polish)
5. Global report on diabetes. WHO. ISBN 978 92 4 156525 7.
6. OECD. Health at a Glance 2015: OECD Indicators. OECD Publishing; [Internet] Paris, 2015 Available from: http://dx.doi.org/10.1787/health_glance-2015-en [cited 2019 Jan 23].
7. OECD. "Premature mortality" in Health at a Glance 2011: OECD Indicators. OECD Publishing; [Interent] Paris, 2011 Available from: http://dx.doi.org/10.1787/health_glance-2011-5-en [cited 2019 Jan 23].
8. Korzeniowska K, Jabłecka A. Cukrzyca (Część I). Farmacja Współczesna 2008;1:231-5. (Polish)
9. Międzynarodowa Statystyczna Klasyfikacja Chorób i Problemów Zdrowotnych Rewizja dziesiąta Tom I, Wydanie 2008. World Health Organization 2009. Centrum Systemów Informacyjnych Ochrony Zdrowia, 2012. (Polish)
10. [Internet] Available from: http://demografia.stat.gov.pl/bazademografia/Tables.aspx [cited 2019 Jan 23].
11. Romeder JM, McWhinnie JR. Potential years of life lost between ages 1 and 70: an indicator of premature mortality for health planning. Int J Epidemiol 1977 Jun;6(2):143-51.
12. Ciabiada B, Dziankowska-Zaborszczyk E, Pikala M, Bryła M, Maniecka-Bryła I. Metody statystyczne zastosowane w analizie umieralności w publikacjach autorów polskich. Probl Hig Epidemiol 2015;96(3):565-9. (Polish)
13. Zalecenia kliniczne dotyczące postępowania u chorych na cukrzycę 2016. Stanowisko Polskiego Towarzystwa Diabetologicznego 2016, Tom 5, Suplement A, ISSN 2084–4441. (Polish)
14. Ahmad L A, Crandall J P. Zapobieganie cukrzycy typu 2: przegląd informacji. Diabetologia po dyplomie. 2010;7(3):9-15. (Polish)
15. Kłosiewicz-Latoszek L, Cybulska B. Cukier a ryzyko otyłości, cukrzycy i chorób sercowo-naczyniowych. Probl Hig Epidemiol 2011; 92(2):181-6. (Polish)
16. Norris SL, Zhang X, Avenell A, Gregg E, Bowman B, Schmid CH, Lau J. Long-term non pharmacological weight loss interventions for adults with prediabetes. Cochrane Data-base of Systematic Reviews; 2005,CD005270.
17. Lindström J, Ilanne-Parikka P, Peltonen M, Aunola S, Eriksson JG, Hemiö K, Hämäläinen H, Härkönen P, Keinänen-Kiukaanniemi S, Laakso M, Louheranta A, Mannelin M, Paturi M, Sundvall J, Valle TT, Uusitupa M, Tuomilehto J. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow up of the Finnish Diabetes

Prevention Study. Lancet 2006 Nov;368 (9548):1673-9.
18. Diabetes Prevention Program Research Group, Knowler WC, Fowler SE, Hamman RF, Christophi CA, Hoffman HJ, Brenneman AT, Brown-Friday JO, Goldberg R, Venditti E, Nathan DM.: 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet 2009 Nov 14;374(9702):1677-86.
19. Szymocha M, Bryła M, Maniecka-Bryła I. Epidemia otyłości w XXI wieku, Zdr Publ 2009;119(2):207-12. (Polish)
20. [Internet] Available from: http://www.who.int/mediacentre/factsheets/fs311/en/ [cited 2019 Jan 23].
21. Araszkiewicz A, Piasecka D, Wierusz-Wysocka B. Ocena wiedzy pacjentów z typem 2 cukrzycy na temat przewlekłych powikłań choroby. Now Lek 2012;81(2):158–63.
22. Krystoń-Serafin M, Jankowiak B, Krajewska-Kułak E, Sierakowska M, Popławska E. Ocena wiedzy pacjentów na temat cukrzycy typu 2 jako niezbędny element terapii. Diabetol Prakt 2005;6(1):7-14. (Polish)
23. [Internet] Available from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Cause sof deathstatistics/pl [cited 2019 Jan 23].