The Economic Impact of Diabetes

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***Abstract*– The number of diabetic people is constantly growing across the globe including Hungary. According to the WHO diabetes is a future endemic problem. Beside the social problems, diabetes causes a serious economic impact as well; hence, it is important to draw attention on it together with its impacts. The paper discusses about this question, introducing the types of diabetes, its indicators, complications (mostly concentrating on type II diabetes), and also its treatments and prevention. Investigation of the changes in diabetic population and also the burden of this disease both in domestic and global levels are discussed as well.**

Keywords—prevalence; diabetes mellitus; health expenditure

I. INTRODUCTION

In the recent decades and years the world has become more and more developed. At the same time, people have become lazier, and show a tendency to live unhealthier, neglecting physical activity, regular meals, etc. As a result, obesity, inadequate blood pressure, reduced glucose tolerance level, or even high insulin level probability increased as a direct indicators of metabolic syndromes. These syndromes also carry the risk of several diseases, including diabetes mellitus. The number of people with diagnosed diabetes (and with undiagnosed diabetes too) is constantly growing across the globe, including Hungary. Due to this reason the World Health Organization considers the disease as an endemic problem to the world [11].

As a result, it is very important to draw attention on diabetes, and its types, indicators, complications (mostly concentrating on type II diabetes / non-insulin dependent diabetes / adult diabetes), but about the treatment and prevention possibilities as well. However, as the disease has a global impact on the society, it is worth examining the changes of diabetic population on other sectors as well, including economic factors. The scope of this paper tries to give a short review on this latter aspect, trying to focus both on domestic and global levels, since the negative effects of diabetes damage not only the lifestyle of a patient, but also generate an additional expenditure of the treatments both for the society and for the national economy.

The paper is structured as follows: first a review on diabetes is presented, than the prevalence of the disease. This is followed by the burden of the disease taking into account the economic factors. Finally a short summary concludes the paper.

II. DIABETES

A. Formations and Symptoms of diabetes

The body's primary energy resource is glucose. For this fuel the body disassembles the intake carbohydrate coming for the meals taken. The glucose (sugar) comes to the veins to ensure the proper functioning of the body.

The amount of glucose given to cells in a healthy person is regulated by insulin. The pancreas is responsible for the production of this hormone. The required amount of this hormone is automatically controlled by the pancreas after a meal. Hence, if the glucose level is too high in the blood it can be concluded that the pancreas does not work well so the produced insulin amount is not enough, or the cells cannot react in the right way to the insulin. As a result, the body is damaged to receive its primary source of energy [6], [7].

Consequently, the main reason for diabetes is the total or partial absence of insulin. The clinical symptoms of this disease are [6]:

- frequent urination;
- polydipsia (continuous thirst feeling);
- rapid weight loss that cannot be explained;
- visual disturbances;
- infection that is difficult to heal and often recurrent;
- diabetic ketoacidosis.

B. Types of diabetes

According to the World Health Organization diabetes mellitus has three primary types [7], [8]:

- type I diabetes;
- type II diabetes;
- gestational diabetes (during pregnancy).

1) Type I diabetes

Type I diabetes is caused by the destruction of the beta-cells that produce insulin within the pancreas. Because of this, insulin injected from outside of the body is essential, as if the patient does not receive it, ketoacidosis may occur leading to coma, the outcome of which could result in the death of the patient. That's why type I is known as insulin-dependent diabetes as well. Usually the symptoms occur before the age of 30. It is also important to note that diabetes type cannot be determined just by age.

The insulin-dependent diabetes has two subtypes. One of them is the 1A autoimmune mechanisms type and the other is the 1B idiopathic type.

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In 1A subtype diabetes occurs by the reaction of the T-cell autoimmune mechanism that (it is a type of white blood cell) destroys the beta-cells. In the adult ages, type I diabetes can evolve as well, referred to LADA (Latent Autoimmune Diabetes in Adults) and it is easy to confuse with type II diabetes.

In 1B subtype the doctors cannot identify the cause of the loss of beta cells and an autoimmune process cannot be detected either.

2) Type II diabetes

In this type, the main reason of diabetes is the slowly developing insulin resistance (the insulin is in the body, but that cannot utilize it in the required amount) and the devastation of the beta-cells (necessary for insulin production). This type occurs most commonly in the adult population, but nowadays the disease appears more and more popular among the young generation. This type has a latent nature, so before evolving there are no clinical symptoms. It is mostly caused by the incorrect / unhealthy lifestyle (both inadequate nutrition and lack of physical activity). Type II diabetes is known as non-insulin dependent diabetes or adult diabetes as well, as in its early stages it does not need external insulin dosage to survive.

3) Gestational diabetes

This is the type of diabetes that was discovered during pregnancy or begins during pregnancy, and includes reduced glucose tolerance of the pregnant women.

Since diabetes may have been formed before pregnancy, the diagnosed young mothers may suffer from type I or type II diabetes. The first test should be carried out between the 24-28 weeks and the second test should take after the sixth week of giving birth.

C. Indicators of diabetes [1], [3], [4]

The main indicators of diabetes are blood and urine. By measuring these it is easy to detect diabetes using regular monitoring even if there is a beginning disorder in carbohydrate metabolism.

One can rightly ask when it is worth looking at the blood or urine glucose level of the patient. The measurements can be done in home environment; blood glucose testing provides a more comprehensive picture of self-testing than urinary glucose testing. However, by finger-tip measurements it is not possible to obtain accurate information about how much deviation differs from the normal value threshold; this measurement is just good to give a rough control of the patient in case.

Other control ways can be signs of diabetes as well: great weight loss with average or high appetite, persistent feeling of thirst with many fluids, visual disturbances, or occasional numbness of the fingers, and, in a drastic case consciousness or coma. However, the examination of asymptomatic persons is also justified in the following cases:

- diabetic patients diagnosed in the individual's family;
- obesity;
- cardiovascular diseases;
- high blood pressure (hypertension);
- high blood lipid levels (hyperlipidaemia).

In the case of asymptomatic people, no far-reaching conclusions can be drawn, even if the standard deviation is high. In such cases it is necessary to do other measurement as well at other times including glucose tolerance test.

Another important indicator of diabetes is the measurement of HbA1C (glycated hemoglobin). This is a long-term indicator. Blood glucose measurement is not triggered by HbA1C measuring as HbA1C is only measured every 2-3 months. By measuring glycated hemoglobin it is able to better determine how successful the treatment is or if there are problems to comply the prescribed diet by its doctor.

Measurement of HbA1C measures the hemoglobin-related (glycated) sugar that transmits the color of red blood cells in the blood. The time of this process gives a picture of it during the last 2-3 months, so this type of study should be done only in such intervals. That is, the higher the patient's blood sugar level, the more sugar will bind to the hemoglobin. A healthy individual has a HbA1C of less than 7% (usually between 4-6%), while the main goal for diabetic patients is to get their level closer to 7%. It is important to achieve this value because the higher the proportion –as far time is moving forward– the chance to occur complication by diabetes is highly increased.

D. Serious complications of diabetes [2], [3], [7]

Any type of diabetes can develop complications – both acute and chronic– that spoil the patient's lifestyle. For this proper medication is required (causing a direct effect on the costs of the disease and globally on the economy). It is important to note that the risk of complications and its costs, together with the treatment costs are also dependent on the progression of diabetes.

Two types of complications can be distinguished, acute and chronic.

1) Acute

We spoke about acute complication when it develops shortly or it is fast moving. Acute complications can develop with diabetes. Such complications are hypoglycaemia (low level of blood glucose) and hyperglycemia (high level of blood glucose). Both complications are life-threatening, as if the patient does not get the proper care, it could be lead to their deaths.

2) Chronic

We spoke about chronic complication when it develops slowly or stands for a long period of time. The more frequent chronic complications of diabetes can be divided into two major groups. One is the microangiopathic group that is characterized by its name (vessel diameter < 500 μm), and is characterized by complications due to the vascular damage. This group includes, among other things, the following degradations:

- eye (retinopathy);
- kidney (nepropathia);
- nerve (neuropathy).

The other group of chronic complications is the known as the macroangiopathic group characterized by cardiovascular damage.

E. *Treatment and prevention* [3], [6], [7]

A diabetic patient's care is determined by two components: the type of diabetes and the occurrence of complications. However, the treatment itself is based on four main pillars:

- diet;
- physical activity;
- oral medication;
- insulin therapy.

The types of treatments are divided into two main groups according to whether they are non-medication or medication based ones. At first, the proper diet and physical activity plays the most important role. These are influencing the non-medication treatment of diabetes as well as in case of preventing diabetes (especially in case of type II diabetes).

In case of medication treatment or insulin injection lower blood glucose and other anti-diabetes medications are in the focus. These compositions are in the A10 (A = Gut and Metabolic, 10 = Antidiabetic Therapy) classification system within the ATC classification system (meaning anatomical, therapeutic and chemical classification system). Insulin based medications are classified in group A10A, while blood glucose lowering in A10B. The oral medication treatment is intended to reduce insulin resistance, increase insulin secretion (control blood glucose levels) or slow down the absorption of carbohydrate from the intestine. For insulin treatment, the primary design aspect is to determine the adequate amounts of insulin throughout the day, taking into account the patient's daily rhythm. Two types of insulin are distinguished (human-traditional and analogue-modern), and the correct choice for the treatment is determined by the physician.

III. Prevalence of Diabetes

A. *Global prevalence of diabetes*

During investigation the age group of 20-79 has been taken into account, as the onset of type II diabetes (the 90-95% of the overall diabetes population) is the most significant within this age range. The Diabetes Atlas published by the International Diabetes Federation (IDF) [10], says that the amount of people affected by 2040 –if the condition incidence remains the same– could be over 642 million individuals within the 20-79 age group. At that time the predicted population of the planet will be a around 9.1 billion; hence, today's 5.6% diabetic population of the World's is estimated to increase to 7% by 2040. Further investigating this prediction, the 20-79 age group –being 64% of the overall mankind– remains constant; hence, in 2040 the estimated prevalence within this group will raise to 11% from 8.8% measured in 2015. The population growth will increase the amount of affected people as well.

Consequently, if the prevalence rises up to 11%, then it can be declared that diabetes becomes globally endemic. Obviously, this is an estimated amount, as the fluctuation of the population cannot be predicted numerically; hence, the number of people affected by diabetes is unpredictable. Figure 1 shows the incidence between 2013 and 2015, within the 20-79 age group (in million).

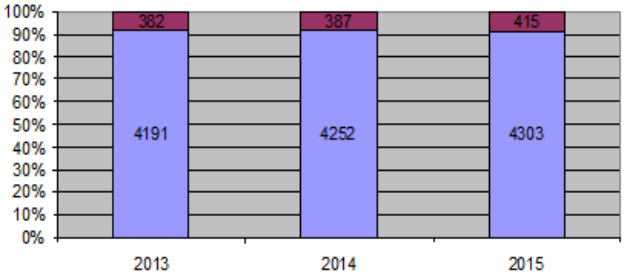

Fig. 1: The rate of the non diabetic and diabetic in the 20-79 years population

B. *Domestic prevalence of diabetes*

According to the statistics of IDF [10], the amount of individuals diagnosed with diabetes was constantly decreasing, but then from 2014 to 2015 there was a significant increase. The result is the change of prevalence level from 7.5% to 9.3%. The subsidence here does not mean that the occurring of diabetes has dropped, but the number of individuals diagnosed with it has been decreased as a result of mortality. The exact number of patients cannot be determined only estimated, mostly dut to the unknown exact number of type II is population (even nationally many individuals don't even know their condition – according to few sources, an estimated population of 1 million people is "latent" diabetes in Hungary). The increase by leaps and bounds is attributable to the more frequent medical examinations, or, in many cases, even the occurring of lifestyle issues caused by the complications of the condition, which led to discover and register it. The fluctuation of prevalence in Hungary can be observed on the Figure 2, within the 20-79 age group (in thousands).

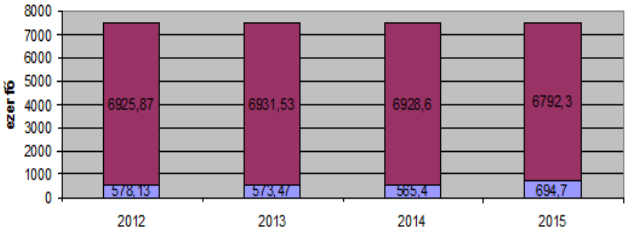

Fig. 2: The rate of the non diabetic and diabetic in the domestic 20-79 years population

IV. The Burden of Diabetes

The burden of the disease can be divided into two major roles. One of them is the healthcare expenditure – about 70% of total costs–, while another is the indirect costs –about 30% of total costs. A few examples of health expenditures:

- Institutional care (hospital or home);
- Outpatient care (medical treatment, emergency care, hospital outpatient care and home or hospice care);
- Medicines (tablets, insulin and their devices).

Indirect costs can be categorized as follows:

- Number of work days lost;
- Limited work;
- Continuous disability;
- Mortality.

As the treatment of diabetes depends on the time discovered, the treatment costs are variable. It is therefore desirable to perform screening tests to detect the disease as soon as possible. Hence, the costs of both medicines and treatments can be reduced as well together with the health expenditures (because the complications generate them mainly).

A. Global

Regarding global level costs, this has a direct influence on Hungarian tendencies. In the world, diabetes caused expenses increase every year. In 2013 the total cost was 548,5 billion USD, that number grew to 611,85 billion USD to 2014 and further, in 2015 to 672,4 billion USD.

In 2015 the North American and Caribbean region spent the most to diabetes and its complications (based on IDF statistics). Next, the European and the Western Pacific region is followed then the South and Central America; Middle East and North Africa; South-East Asia and finally Africa. Given the global level of total spending (672.4 billion USD) it can be observed that slightly more than half (51%) of the expenditure belongs to the North American and the Caribbean region. Hence, at global level, 51% of the total costs were spent on 10.6% of the total individuals with diabetes. By comparison, the region with the largest number of patients (Western Pacific) with nearly 36.9% of patients from the whole diabetic population accounted only 15.7% of the total 2015 diabetes expenditure.

To illustrate the dimension of global diabetes costs it could be mentioned that Hungary's public debt in 2015 was 80,395 billion EUR, which converted with the current exchange rates is equal to 87,739 billion USD. Hence, the 2015 global diabetes costs are 7,6 times bigger than the whole Hungarian public dept.

B. Domestic

According to the statistics of the IDF [10], the amount of diabetes related health expense in Hungary was 1158 USD/head in 2014, while in 2015 was 1208 USD/head. In 2014 the Hungarian population was 9 877 365, and the domestic prevalence was 7,51%. Hence, according to the IDF there were 741 790 people with diabetes, and that overall costs covered 859 million USD (around 250 billion HUF predicted value). By 2015 the Hungarian population decreased to 9 855 571 persons, and with the 2015's prevalence (9,3%) in Hungary were 916 568 people with diabetes, with a total expense of 1107 million USD (around 322 billion HUF).

It is worth examining the costs changes in the treatment with drugs too. Figure 3 shows the financial changes (in million HUF) in the insulin type medicals during 2012 and 2016.

According to Figure 3, from the year 2013 the insulin type medical expenses constantly grew (insulin type can be A10AB -fast-acting insulin- , A10AC -intermediate-acting insulin-, A10AD -intermediate or long-acting combined with fast acting insulin- or A10AE -long-acting insulin- ATC code drugs). With blue one can see the changes the health insurance costs, dark red reflects the changes of medication price, while yellow the costs of health care support. From 2013 the gross consumer price was grown by 2598 million HUF.

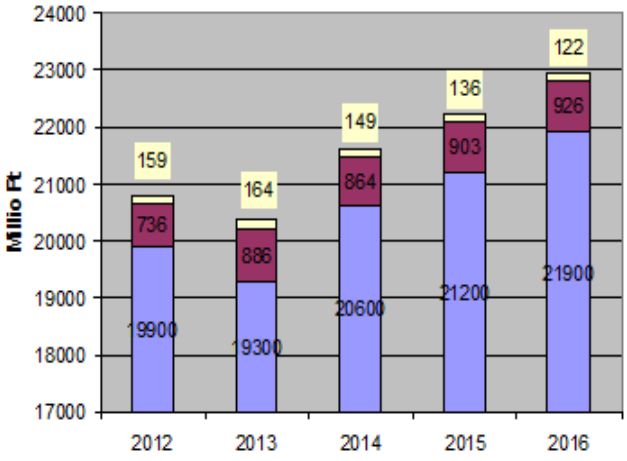

Fig. 3: The financial changes in the insulin type medicals

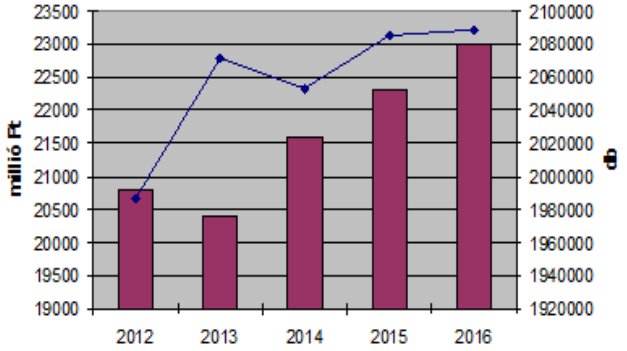

Fig. 4: The insulin type drugs turn overs by price and sold boxes

Figure 4 shows the summed A10A ATC code drugs changes by sold boxes and the gross consumer price in million HUF between 2012 and 2016.

It can be seen that in the monitored time, by the year 2014 the sold boxes and the gross consumer price started to grow constantly (the gross consumer price started the increasing tendency by 2013). There was clearly a price increase from 2015 to 2016, because the sold boxes are nearly equal, but the consumer price has grown by nearly 700 million HUF.

This significant increase in the price could be triggered by the possible market price increase or by the changes in the drugs classification type (96% of the price growth was covered by health subsidies, while the remaining 28 million HUF was financed by the patients themselves).

Furthermore, the research contained the A10B blood glucose lowering drugs financial changes. This ATC code contains the A10BA (biguanides), A10BB (sulfonylureas), A10BC (sulfonamides), A10BD (combination of oral glucose lowering drugs), A10BF (alpha-glucosidase inhibitors), A10BG (thiazolidinediones), A10BH (dipeptidyl-peptidase-4 inhibitors) and the A10BX (other blood glucose lowering drugs excluding insulin).

Figure 5 shows the sold boxes (each) and the gross consumer price (million HUF) changes during the 2012-2016 period.

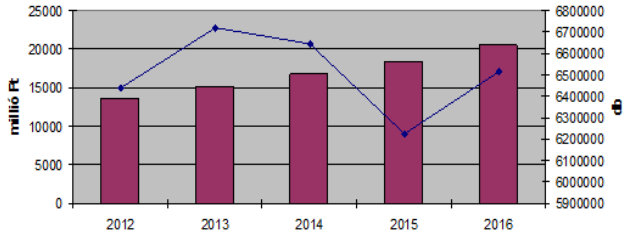

Fig. 5: The non-insulin type drugs turn overs by price and sold boxes

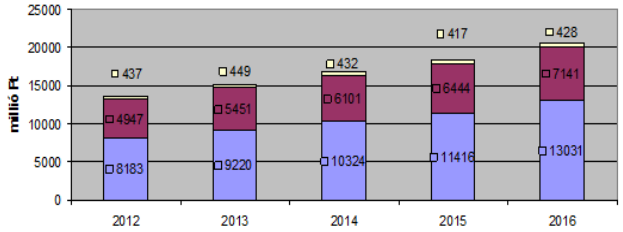

Fig. 6: The financial changes in the non-insulin type medicals

The number of the sold boxes constantly decreased from 2013 until 2015, then by the year 2015 to 2016 the sold boxes amount raised up again, nearly above the sold quantity in 2012 (in 2012 the number of the sold boxes were 6.441.955 each and in 2016 were 6.517.368 each). During the examined time the sold amount of boxes were always above 6,4 million each (except in 2015); it is a huge number in spite of the fact that the sales only reached the 2012's numbers. Hereby the gross consumer price growth year by year, notwithstanding that the sold number of boxes decreased from 2015. Consequently, the drugs price in the A10B ATC code also increased during the years just like the A10A ATC code drugs' price.

Figure 6 shows the financial changes during the monitored time (2012-2016) in the A10B ATC coded medicines, in million HUF. As one can see, in this type of drugs the fee is much bigger and the support by health insurance is much smaller than the insulin-typed drugs. This resulted due to the fact that the A10B ATC codes drugs are less supported by the public sector.

In summary, it can be declared that the cost tendencies constantly grow in both types of medicines (A10A and A10B).

From the public side, during the monitored time the support of healthcare has been developed as follows (rounded data): in 2012 it was 28 billion HUF, in 2013 it cost 28,5 billion HUF, in the year 2014 cost 30,9 billion HUF, and in 2015 it growth to 32,6 billion HUF, and for 2016 the costs increased to 35 billion HUF.

During this time an additional 7 billion HUF plus expenditure appeared at the public level. This extra amount of cost was generated by the increased support by the public sector with the A10B ATC coded drugs (during the monitored time, this type of drug support growths by 5 billion HUF, that is nearly 2 times bigger than the costs increase in the private sector). It is important to notice that the support by healthcare has been paid by the affix paying people as well, not only by the public sector.

From the patient side, the expenditures also increased year by year in both types of drugs. The numbers are as follows (rounded data included the people with health care support): in 2012 it was 6,2 billion HUF, in 2013 it cost 6,9 billion HUF, in 2014 it was 7,5 billion HUF, in 2015 7,9 billion HUF, and in 2016 the private burden increased to 8,6 billion HUF for the people with diabetes. The fee of the patients grew with a total of 2,4 billion HUF in the monitored time (likely in the A10B type where the expenditures growth by 2,2 billion HUF while in the A10A type drug costs only increased by 200 million HUF).

It is important to point out that this type of costs of disease is only on the shoulders of the diabetic population. At the above-mentioned data the question is whether the burden is high for the domestic diabetic population, while there is a double burden on patients who are actively working.

Furthermore, the above examined costs do not include the expenditures generated by the disease complications due to the lack of enough certified data. As a result, only the financial changes in the drugs type were monitored; however, important amount of cosst occurred by the complications in health expenses (e.g. see [5], highlighting that the total expenditures for diabetes including the cost of complications were 175 billion HUF).

Since diabetes have many complications that can seriously affect the lifestyle of a patient, it is also important to look at the indirect costs generated by this disease (for example, the diabetic foot amputation, stroke or heart attack). If the patient experiences the above-mentioned examples they should be treated by doctors. For this reason, the patient is receiving in-patient care for a while which occurs in healthcare expenses, but when talking about an employee, it is likely that many work days will fall out, and even the incapacity of work may occur; furthermore, if they fail to treat the patients in time, or if other complications occurs, it can also lead to the death of the patient.

Since there is no available database where the number of diabetics registered among the active workers and the lack of sources on complications, only the cause of death has been analyzed. Such costs include, for example, the funeral and rental of plots. Naturally, in larger cities the costs are higher than in the rural areas. Funeral prices are greatly influenced by the needs of deceased relatives. According to the data of the Budapest Funeral Institute [9], the price of a funeral starts at about 70 000 HUF and the total amount can be up to 250 000 HUF – the price does not include the administrative fee or the amount charged for the preparation (the latter range between 23 000 HUF and 45 000 HUF, while the former costs between 7 000 and 22 000 HUF).

Consequently, it can be stated that mortality is also a serious cost for the relatives, as the cost of a burial is around 100 000 HUF, but can reach up to 300 000 HUF. As the present minimum wage in Hungary is 127 000 HUF, it is clear that a funeral has serious financial implications and can be a serious burden for the family.

V. Summary

At global level, the cost of diabetes increases year by year, but it is really interesting that growth in the North American and Caribbean region is the largest in the period under review of this study, and it also spends the most in this region (about 50% of total expenditure), while only about 10.6% of patients are located there. The costs will increase in a long term because of the latent nature of type II diabetes. At global level, the costs occurred by diabetes grows year by year (both in the private and public sectors) in Hungary too.

Summing up the tendencies of the recent years in Hungary, diabetes mellitus prevalence increases in the domestic population and the costs of the disease also generates a bigger burden year by year for the economy. There is currently no economic solution for reducing this burden only the prevention could decrease the costs.

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