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**Health Economics Analysis –  
Individual Cost Estimation Models in  
Practice for Type 2 Diabetes in Hungary**

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## **Health Economics Analysis – Individual Cost Estimation Models in Practice for Type 2 Diabetes in Hungary**

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### **Abstract**

Within the framework of New Hungary Development Plan, the goal of Hungary's Social Renewal Operational Program (NHDP/ TÁMOP) was to implement successful projects in the period of 2007- 2013 that concern the country's society as a whole. The projects supported by the operative program of NHDP also include international research collaboration. Thus, under the aegis of NHDP a health economics-related project titled, "IT supported comprehensive multipurpose, medical, economic and educational use of clinical data" with the name MEDIC SPHERE was carried out. The main components of the project were the following:

1. Data security alert, analysis-centered data collection and integration
2. Implementation of a case-dependent clinical cost-benefit model
3. Implementation of case-dependent, economically aware clinical protocols
4. Implementation of video analytical solutions for simulated data generation
5. Generation of simulated 3D environment for educational and preparatory purposes

The present study focuses on the results connected to the second stage of the project. The present purpose of the project is to prepare the benefit-based measuring model of clinical cases involved in the research: the disclosure of direct and indirect expenses related to the cases, the implementation of measuring methods, and the preparation of related „health benefit (gain)” methods at the social level.

The cost-benefit analysis is considered as a less broadly used method not only in the economic evaluation of health related technologies in Hungary, but also internationally. The reason for this is the lack of detailed elaboration of its methodology and the lack of experience based on its application in practice. The goal of the project was to fill in this gap by elaborating and applying the

method of cost-benefit analysis for one particular disease type, namely diabetes.

During the implementation, a simulation model is prepared for the cost-benefit analysis of the different methods of treatment. When performing a cost-benefit analysis, health-benefit (gains) is complemented by direct effects (benefits), alternative costs occurring on a social or individual level, which are compared with costs and thus the model offers an economically optimal solution.

In case of successful implementation, the preparation of the patient journey can involve significant added sources for the budget and the Hungarian economy as a whole. This way the results of clinical treatment can be measured, and by including and adjusting patients and environmental effects, the social benefit of the health sector can be expressed in a complex way, in addition to the formerly used statistical figures.

**Keywords:** Health Economics, Cost-benefit Analysis, Utility, Diabetes.

## **Introduction**

The aim of the Hungarian project titled ‘Medic Sphere’ IT supported application of clinical data for complex, multipurpose, medical, economic, and educational purposes is to prepare a benefit-based measuring model for the outcome of the clinical cases being part of the study, to explore the related direct and indirect costs, to work out the related measuring method, and to develop a method to consider the health benefits on the level of the society. The research team has worked out the cost-benefit analysis for one particular disease, which is type 2 diabetes.

The study presents the cost structure and classification of cost types as compiled by the research team. The main feature of the compiled cost structure is that it takes two factors into consideration at the same time: the phases of type 2 diabetes and the cost centres and cost types.

The primary aim of this descriptive research is to accurately present the structure of the cost matrix being the basis of the cost analysis, and to determine the professional content of the various cost type and the method of their consideration.

## **Material and Method**

This study has a dual methodology. On the one hand, the description of the cost matrix is primarily descriptive. The secondary sources of the matrix description study include the studies conducted by the members of the research team, the list of costs compiled by the research team and the hospital database.

On the other hand, the study is also quantitative in its character since in the scope of the cost estimation prepared for phases 1-4 of diabetes mellitus the database of the Zala County Hospital (ZCH), the data collected by a questionnaire survey on the target team, the estimated costs of the disease based on the relevant legal regulations and the methodology of estimation are presented. As far as the data processing methodology is concerned, the study has a statistical character as part of which Excel applications allow for allocating and presenting the costs.

## **Results**

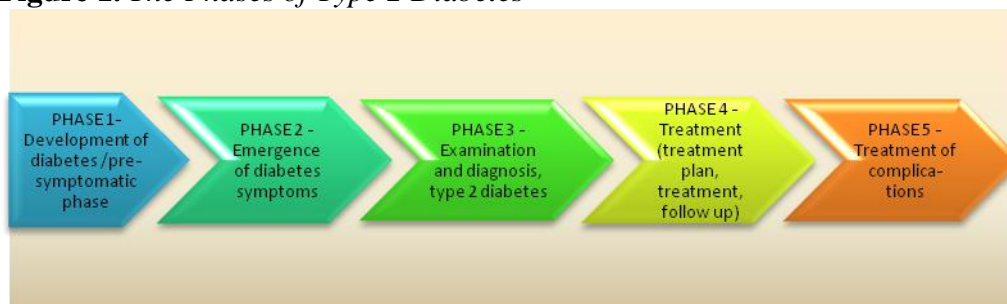
### *The Logical Structure of the Cost Matrix*

Similarly to other developed countries, Type 2 diabetes is also a central public health problem in Hungary. Diabetes-related costs can vary highly depending on the type of disease as well as the applicable treatment, prevention or nursing protocols.

As a result of the structure of the Hungarian health care system, treatment costs are basically borne by two agents: the patient and the state. The magnitude of costs is largely dependent on which particular phase of the

disease the patient can be categorised into. The research team broke down the disease into five phases (*Figure 1*).

**Figure 1.** *The Phases of Type 2 Diabetes*



Source: List of costs compiled by research team

It is a highly complex task to consider all costs. In order to determine cost types, the research team considered those used by WHO and found in other international literature, the methods used in national health economic analyses while the cost structure was determined with due consideration of the structure of the Hungarian health care system [1].

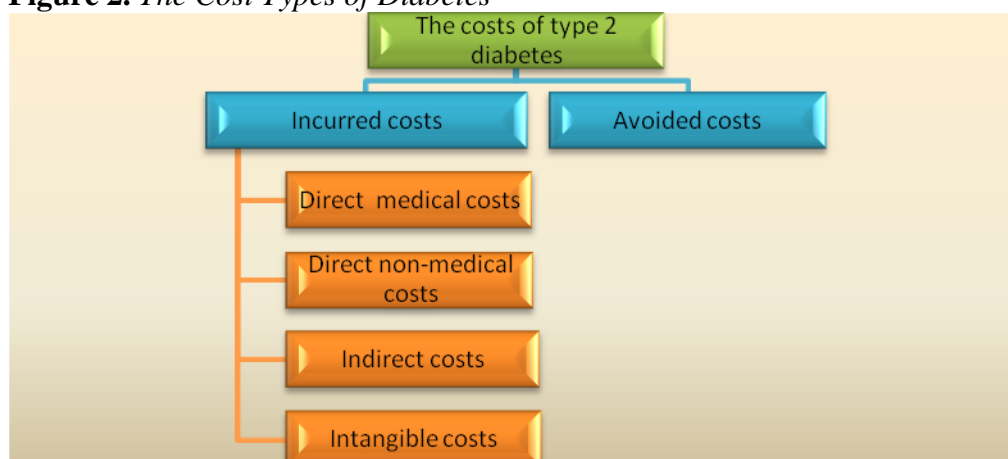
The cost matrix includes the cost structures for the disease phases along two dimensions. The two main criteria for establishing these categories are nothing else than the cost bearers and the cost types.

Disease costs are generated on two levels: on the patient's and on the state's level, and therefore they are the main cost bearers. In phases 3 to 5 of the disease, under prevailing Hungarian legal regulations, patients' employers also appear as cost bearers due to the sickness benefit contributions paid to patients. Based on the structure of the Hungarian health care system, the costs emerging on the state level can be further broken down into three subcategories: the costs of primary care, specialty care costs, and the drug budget.

Within the framework of primary care, should the patient involved be a student participating in the educational system, the treatment of the disease can also take place as part of the school health care system and the service provided by school nurses. As part of using the specialty care services, patients can also appear as cost factors in primary dental care. Still we can state that primary and out-of-hours GP care have vital roles.

The majority of patients generate costs within the framework of specialty care. As regards the specialty care system, the most relevant areas are laboratories, outpatient specialty care, active inpatients care and chronic inpatient care. An independent unit of the health care system is the drug budget. The costs on this level primarily start to emerge in phase 4 of the disease.

When determining the different cost types, the research team took the cost classification of WHO regarding *diabetes mellitus* into consideration [8]. The cost matrix assigns cost categories determined in the international literature to each cost bearing level. The cost category types are presented in Figure 2.

**Figure 2.** *The Cost Types of Diabetes*

Source: List of costs compiled by research team [2],[9]

### *Cost Structure*

When approaching costs according to individual patient paths, special attention must be paid to the two main classifications of costs: the determination of emerging and avoided costs.

As regards to avoided costs in the cost matrix, we have to consider costs related to primary and secondary prevention. In terms of primary prevention costs mainly arise on the patient's level since the costs arising from a change in patients' lifestyle are borne by the patients themselves. In the case of secondary prevention, the primary cost bearer is still the patient, however, at this point, the costs of certain examinations (glucose level measurements, diabetic retinopathy screening) also emerge on the level of the health care system. Avoided costs will be estimated in later phases of the research [6],[7].

The cost matrix breaks down incurred costs into four further subcategories. The internal cost teams follow the logic of direct and indirect costs while also considering intangible costs among cost categories.

Resulting from the type of direct medical and health care costs, the type of the cost rather limits on which level of the health care service they emerge. The model takes the following cost factors into consideration: costs of hospital or medical treatment (e.g. wages, benefits, overhead costs), cost of laboratory tests, drug, medical equipment used for the treatment [5]. Among the cost bearers of direct, non-medical costs we can see the patient with the highest cost borne, while also the state and the employer appear as well. The latter two cost bearers appear when patients receive sickness benefits [10]. The list of direct costs appearing on the patients' level has a wide range. We can state as a start that the phase of the disease influences the costs incurred by patients [9]. Among other things, the following factors have appeared to be the most significant ones: additional costs due to changed lifestyles (diet, exercise), glucose level testing, cost of drug, traveling costs incurred to seek treatment, costs of treatments not included in the protocols (podiatry, eyes and skin treatment, Bemer therapy) [3].

Among indirect costs on the patient's level, the model also considers the lost income and the invested work time of relatives and family members participating in the treatment. As regards intangible costs, the model also takes the additional costs into consideration that result from the deterioration of patients' quality of life and their lost income.

When determining the cost structure, the research team paid special attention to mapping the complications of the disease. *Diabetes mellitus* is accompanied by macro- and microvascular complications. These complications can be divided into two fundamental categories according to type; we can distinguish between chronic (long-lasting) and acute complications (developing fast and/or having a fulminant course) [4].

If complications emerge, costs significantly increase. This cost increase results from the additional costs of drug and medical therapeutic equipment, while, on the level of the hospital health care system, outpatient interventions and operative surgeries cause a major cost burden.

#### *The Contents and Data Sources of Cost Factors*

This chapter describes the cost factors incurred in the various phases of the disease as well as their calculation methods.

The process followed to work out the cost estimation methods for each cost item is as follows,

1. Determination of the data type and content used for the estimation (input data, fixed parameter).
2. Determination of the cost calculation method according to the data used (output data).

The cost calculation method yields a formula to calculate the cost assignable to the specific cost item.

Sources of data series (input data) are assigned to each cost item. The contents of the specific costs are primarily defined by cost types while their values are determined according to cost centres. The sources of the data series used to determine each cost were the following: anonymised hospital data, data gained from interviews with doctors and the patients' questionnaire database. Based on these data series, what's called, fixed parameters were assigned to each cost type. Fixed parameters serve as input data and a cost calculation was prepared for each cost item bearing in mind the prevailing legal regulations.

#### Cost Calculation related to the Emergence of Diabetes and the Pre-symptomatic Phase

Within the phase when the disease emerges patients generally discuss their symptoms with their GPs. In this phase, according to the GP protocol, the main aim is to establish an early diagnosis of diabetes. According to GP practice, patients with high risk factors are advised on proper lifestyle and sent for routine tests in order to reach an established diagnosis. In the GP's surgery an initial blood glucose measurement is completed and high-risk patients are



referred to the laboratory for fasting blood glucose measurement. In terms of cost centres, in this case, disease costs are generated on three levels; on the levels of primary and specialty care as well as on the patient's level.

### 1. Direct medical costs

#### Cost calculation on primary care level

In this respect costs arise on two levels of the health care system. Patients visit their GPs to discuss their symptoms. Costs arise on the level of primary care in connection with this examination, resulting in material costs (costs resulting from the use of diagnostic equipment), wage costs and overheads.

Based on the data collected by GP interviews, GPs incur the diagnostics costs specified in the following table (*Table 1*).

**Table 1. Costs Arising on the Level of Primary Care**

Type	input (GP )	fixed parameter (GP adat )		output	cost per patient
Unit of measurement	Number of occasions (occasion /year)	frequency/ occasion	HUF/occasion	HUF/year	for a 1300-strong practice
Blood pressure meter	1	0.25	20 000	5 000	3.85
Blood glucose meter	1	0.25	22 480	5 620	4.32
Test strip	1	4.00	8 400	33 600	25.85
Pen	1	4.00	3 830	15 320	11.78
ECG machine	1	0.10	1 000 000	100 000	76.92
ECG gel and cost of printing	1	12.00	50 000	600 000	461.54
Doctor's wages	1	8.33	250 000	2 083 333	1 602.56
Medical assistant's wages	1	8.33	150 000	1 250 000	961.54
Surgery overheads	1	8.33	100 000	833 333	641.03
<b>Total</b>					<b>3,789.39</b>

Source: compiled by research team based on the database of in-depth interviews with GPs

#### Cost calculation on the level of specialty care

The disease generated costs on the level of specialty care as a result of the laboratory test completed (*Table 2*).

**Table 2. Laboratory Test Costs Incurred as Part of Outpatient Specialty Care**

Type	input (patient)	fixed parameter (ZCH database)		output
Unit of measurement	Number of occasions (occasion/year)	frequency/ occasion	HUF/frequency	HUF/year
Laboratory	1	1	1814	1814

Source: compiled by research team based on the database of the Zala County Hospital

## 2. Direct non-medical Costs

We mainly relied on the findings of the primary research conducted on the target group to estimate costs.

### Cost Calculation on the Patient's Level

When making the cost calculation we considered that patients mostly cover the distance between their homes and the GP's surgery by public transport. The database of the primary research indicates that the average distance to cover to visit a GP is 2.7 km, and to have laboratory tests made is 7.6 km. With a view to this fact, we calculated the costs with public transport fares assuming return trips. We also defined the additional costs incurred by patients as a result of their changed lifestyle based on the database of the primary research and the average of the amounts specified by patients was used to estimate the gratuity cost (*Table 3*).

**Table 3.** *Direct non-medical Costs in Phase 1 of the Disease*

Type	input (patient)	fixed parameter (Questionnaire survey)		output
Unit of measurement	Number of occasions (occasion/ year)	frequency/ occasion	HUF/ frequency	HUF/ year
Cost of visiting doctor	1	1	480	480
Cost of visiting the laboratory	1	1	480	480
Additional costs of change in lifestyle	1	12	8 640	103 860
Gratuity	1	1	13 650	13 650
Total				118 290

Source: compiled by research team based on questionnaire survey database

## 3. Indirect costs

Among indirect costs we considered the net wages payable on sick leave and holiday to the patient and a family member so that they can visit the GP.

### Cost Calculation on the Patient's Level

We considered the net average wages in Zala County in the cost calculation (*Table 4*) that are published by the Central Statistical office for 2013 and amount to HUF 118,130 HUF/month [11].

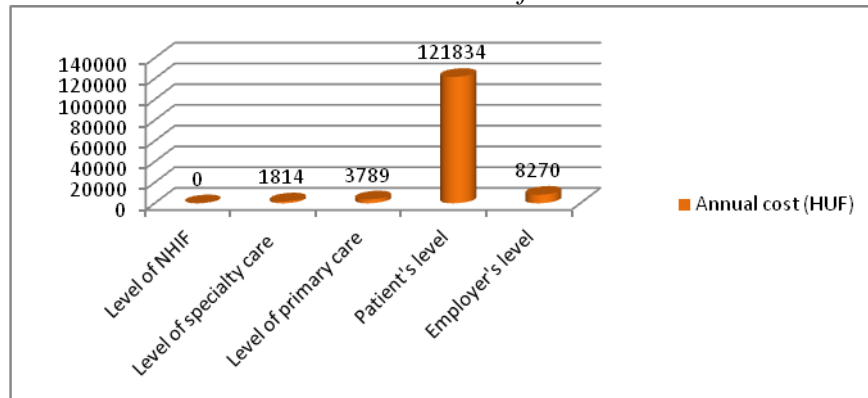
**Table 4. Indirect Costs in Phase 1 of the Disease**

Description	Average wage	Average number of working days	Days of sick-leave	Rate	Amount
Type	input (patient)	fixed parameter	input (patient)	fixed parameter (legal rule)	output
Unit of measurement	HUF/month	day/month	day/year	%	HUF/year
<b>Employer's level</b>	118 130	20	2	70	<b>8 269</b>
<b>Patient's level</b>	118 130	20	2	30	<b>3 544</b>

Source: Own Compilation based on the Questionnaire Survey Database

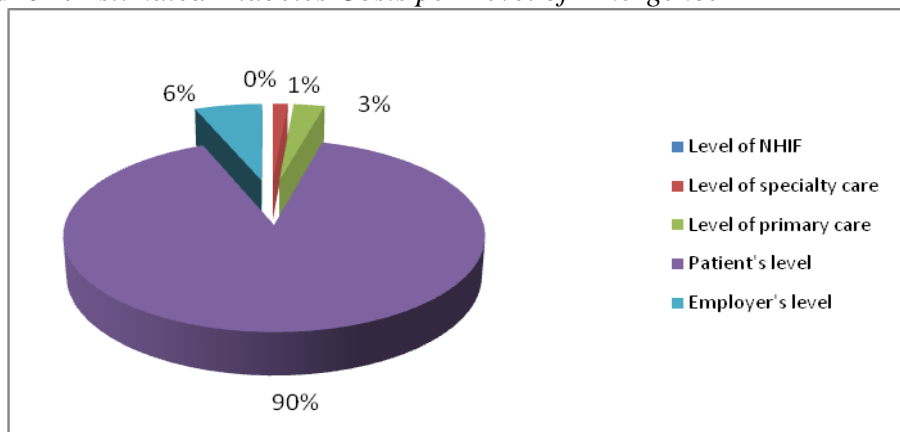
Total costs in phase 1 of diabetes: HUF 135,707. Nearly 90 % of the costs arise on the patient's level while the cost bearing of further levels is meagre in the phase prior to the emergence of the disease/symptoms. The two diagrams below illustrate the development and distribution of costs (Figure 3, 4).

**Figure 1. Estimated Cost Values in Phase 1 of Diabetes**



Source: Compiled by Research Team based on Cost Calculation

**Figure 2. Estimated Diabetes Costs per Level of Emergence**



Source: Compiled by Research Team based on Cost Calculation

In the following we don't present the detailed calculations, but we mention the main features and differences of further phases of the disease.

### The Emergence of Diabetes Symptoms Phase

When diabetes symptoms emerge, patients first and foremost visit their GP first with their demand for medical care, while in some more severe cases it might be necessary for patients to seek emergency GP care. Patients are treated according to the GPs' protocol in this phase. The fasting blood sugar level will decide what treatment path patients are to follow in order to have their symptoms and disease attended to. In this phase, patients usually visit the health care services more often, four times a year on the average.

#### 1. Direct Medical Costs

In this phase of the disease patients generate costs on the levels of primary and specialty care. GPs are visited upon the emergence of the symptoms. GPs attend to their patients according to GP protocols. This has also been confirmed by the in-depth interviews conducted with GPs and the qualitative data of these interviews (four times annually with symptoms) were also considered in our cost calculation. GP practice indicates that attending to a patient generates material costs (costs arising out of the use of diagnostic equipment), wage costs and overheads. Interviews with doctors revealed that in the phase when the symptoms emerge patients are also attended to by the out-of-hours GP system at times. Medical attention generates wage and material costs also on the level of primary care.

On the level of specialty care the disease generates costs resulting from the laboratory tests performed upon the GP's referral.

#### 2. Direct Non-medical Costs

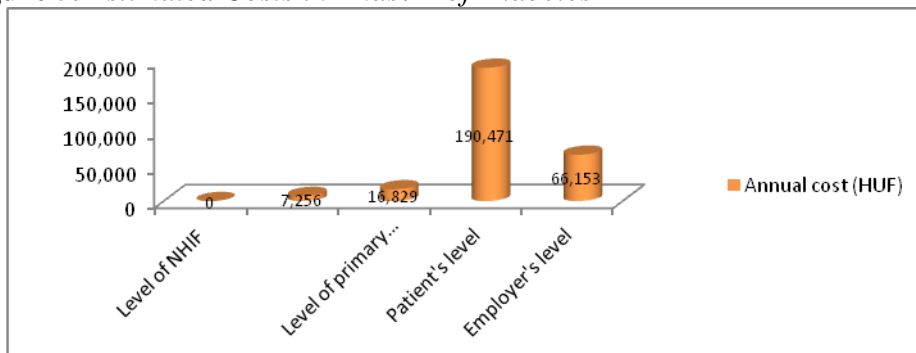
When determining direct non-medical costs we considered that in this phase of the disease patients visit their GPs more often and the doctor sends them for laboratory tests in order to establish a diagnosis. Patients' travelling costs increase when visiting the various levels of health care services. According to GPs' protocol, in order to mitigate symptoms, GPs prescribe a change in lifestyle (a diet, physical exercise) and the resulting additional costs shall appear on the patient's level. The expenses incurred in the form of gratuity were determined in the scope of the primary research conducted among patients. We included these costs in our cost calculation.

#### 3. Indirect costs

When determining indirect costs, we followed the procedure worked out in phase 1, which meant that we considered the costs arising out of sick-leave taken by patients and their family members to visit the GP and the laboratories. However in this case we calculated with two persons (the patient and his/her family member) and 4-4 occasions a year on an annual average.

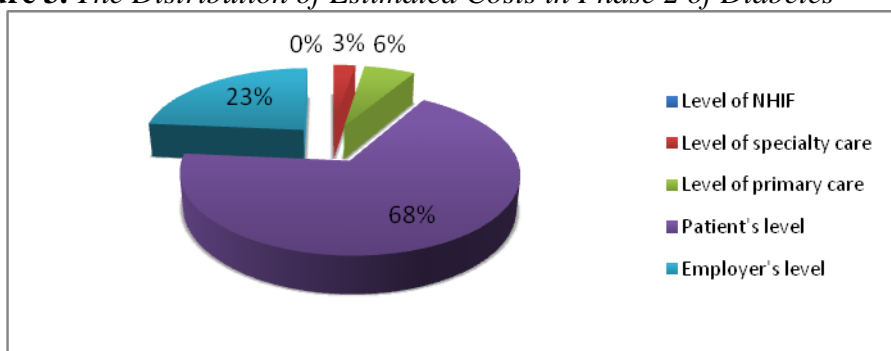
In the phase when the symptoms of diabetes emerge (phase 2), the estimated costs amount to HUF 280 709. The cost centre analysis indicates that the majority of costs are incurred by patients (68%). This fact is presented by the following diagrams (Figures 5 and 6).

**Figure 5. Estimated Costs in Phase 2 of Diabetes**



Source: Compiled by Research Team based on Cost Calculation

**Figure 3. The Distribution of Estimated Costs in Phase 2 of Diabetes**



### The Examination and Diagnosis Phase of Diabetes

This phase may be considered as the phase in which diabetes is diagnosed. Patients are generally attended to according to the GP protocol. In this phase mapping the risk factors typical of the initial status and gathering information indicative of a possibly existent intercurrent disease (e.g. hypertension, hyperlipidaemia) and diabetic complications (e.g. retinopathy, nephropathy, neuropathy) are of utmost significance. In this phase costs arise in connection with tests taken at the GP's surgery, laboratory tests and tests related to specialist consultations on the level of the health care system. Patients primarily incur travelling costs to have a diagnosis established and in terms of indirect costs we must consider costs arising out of patients' sick-leave.

#### 1. Direct Medical Costs

In the GP's surgery physical tests and diagnostics tests are performed in order to establish a diagnosis. Costs in this phase arise in a similar structure to that of phase 1 with the difference that the examination by the GP takes longer

to establish a diagnosis. In the interviews conducted with GPs doctors defined an average of 30 minutes spent with their patients.

An important element of the examinations is the fasting blood glucose laboratory test. The examination cost arises on the level of the specialty care system. We estimated average laboratory test costs based on the database of the Zala County Hospital by taking ICD codes into consideration that served as the basis for the main diagnosis requiring treatment.

In this phase of the disease direct medical costs are largely dependent on how severe the patient's condition is. The GP protocol defines guidelines for the doctor as to what specialist consultations are required in order to identify concomitant symptoms and complicated status. These are: ophthalmologic, neurological, medical, dermatological and nephrological examinations. In the scope of the cost calculation we considered all the costs incurred related to specialist consultation.

In this phase of the disease the costs significantly increase on the level of the health care system and total HUF 345 940.

## 2. Direct Non-medical Costs

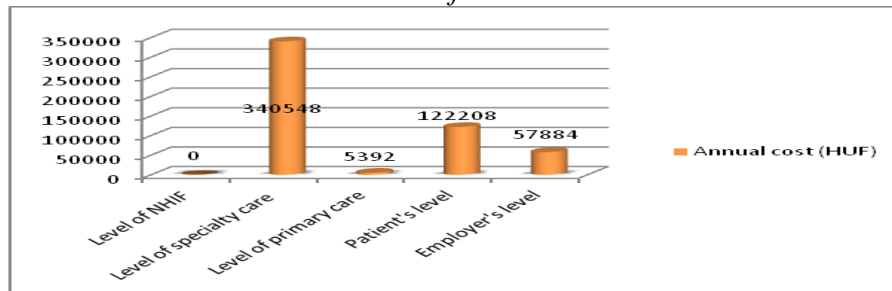
In the course of establishing a diagnosis, on the patient's level, several cost items generate expenses. E.g. travelling costs between the home and the health care institute where health care is provided, additional costs arising out of the change in lifestyle (we calculated with a one-month period based on doctors' interviews and this is what we consider as an annual cost), the amount of gratuity given to doctors as well as the publications, books and internet subscription paid for in order to gain knowledge about the disease.

## 3. Indirect Costs

Also as in phases 1 and 2 of the disease, patients can only take part in examinations performed in this phase of the disease by taking sick-leave. The questionnaire survey shows that patients usually ask a family member to accompany them for treatment. Therefore we calculated with two people.

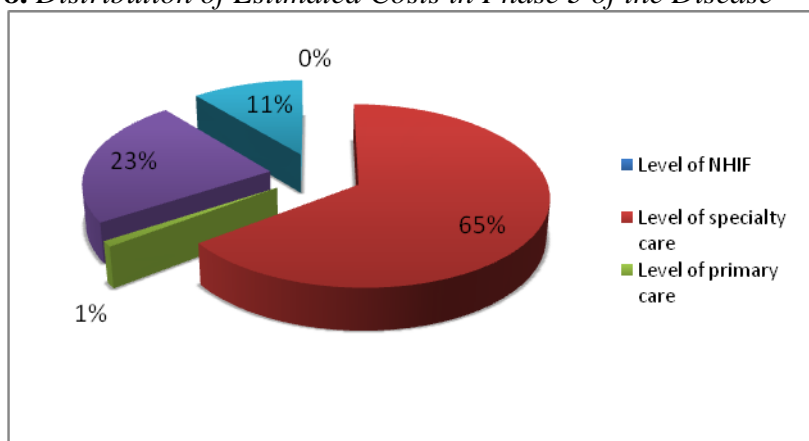
In phase 3 of the disease our total estimated cost amounts to HUF 526 032. In terms of cost bearers, in this phase, the highest cost is generated on the level of the health care system; its percentage reaches 65%. The development and distribution of costs are presented in the following two diagrams (*Figures 7 and 8*).

**Figure 7. Estimated Costs in Phase 3 of the Disease**



Source: Compiled by Rresearch Team based on Cost Calculation

**Figure 8.** *Distribution of Estimated Costs in Phase 3 of the Disease*



Source: Compiled by Research Team based on Cost Calculation

### Phases of Diabetes Treatment

Patients can go down two paths during the treatment phase of diabetes in terms of the health care system. Patients either continue to be treated by their GPs or they are referred to specialty care for further treatment with continuous support from their GPs. The type of treatment defines the amount of cost fundamentally. Relying on the data of the questionnaire survey conducted on the target group we prepared a cost estimation for the combined (specialty care – GP care) treatment based on the properties of the sample.

#### 1. Direct Medical Costs

The interviews made with the GPs suggest that following the diagnoses of the disease patients visit their GPs with a higher frequency. As part of GP care GPs firstly advise their patients in terms of an individual diet and more intensive physical exercise. According to GP protocol 4 types of therapy can be followed in the case of each patient. We considered the following factors when estimating the treatment costs in the scope of primary diabetes care.

An important element of the therapy is the more intense control of patient blood glucose levels. As part of each visit to the GP patients participate in a laboratory test. We estimated average laboratory test costs based on the database of the Zala County Hospital by taking ICD codes into consideration that served as the basis for the main diagnosis requiring treatment.

In treating type 2 diabetes, diabetes specialist consultations play an important role. Research conducted on the target group indicates that patients visit specialty care three times a year on the average.

In phase 4 of type 2 diabetes the health care system is burdened by a cost of HUF 207 312 in a calendar year (2013).

#### 2. Direct Non-medical Costs

The costs arising on the patients' level cause significant additional expenses in the treatment phase of the disease for patient's household. The

additional costs arising out of changing their lifestyle and buying prescribed and recommended drug are outstanding.

As part of the cost estimation we considered the case numbers and prices related to the various cost items as defined by the questionnaire survey conducted on the target group and the focus group survey.

During the disease, patients take oral antibiotics as part of the mono and combined therapy in order to treat their symptoms. Patients get subsidies for the prescribed drug when purchasing those drugs. In terms of costs, the amount of the subsidy is the incurred cost.

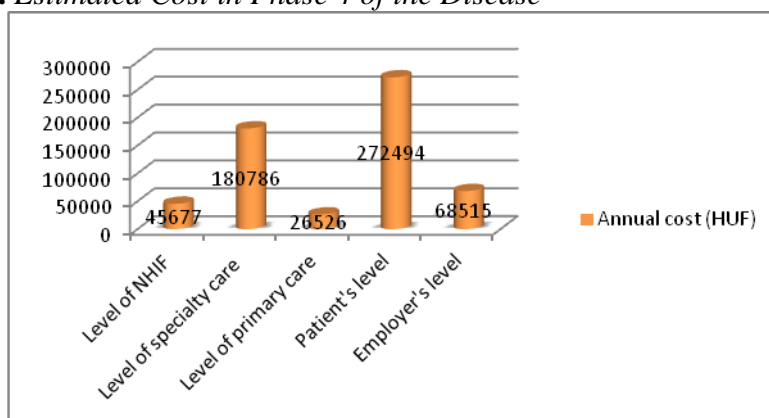
### 3. Indirect Costs

In phase 4 of the disease patients miss a lot at their places of work due to the adjustment of the therapy and the implementation of the treatment. For the period of their disability to work patients are allowed to take a sick-leave and receive sick pay. Similarly, in phases 1 and 2 of the disease patients can participate in the examinations by taking sick-leave. The questionnaire survey indicates that patients are accompanied by their family members to the examinations by taking sick-leave.

The detailed rules to calculate sick benefit are governed set forth in Section 43 - 49 of Act LXXXIII of 1997 on compulsory health insurance [12]. The social security contribution payable by the employer is defined in Paragraph 5 of Section 19 of Act LXXX of 1997 on the eligibility for social security benefits and private pensions and the funding for these services [13].

The estimated total cost of the disease in phase 4 is HUF 619 414, which amount is the highest of the four examined phases. On this level, we must highlight to levels of cost bearers that of the patients' (with their 46% share) and of the specialty care system (with their 30% share). The levels and distribution of costs is presented in the following two diagrams in phase 4 (*Figures 9 and 10*).

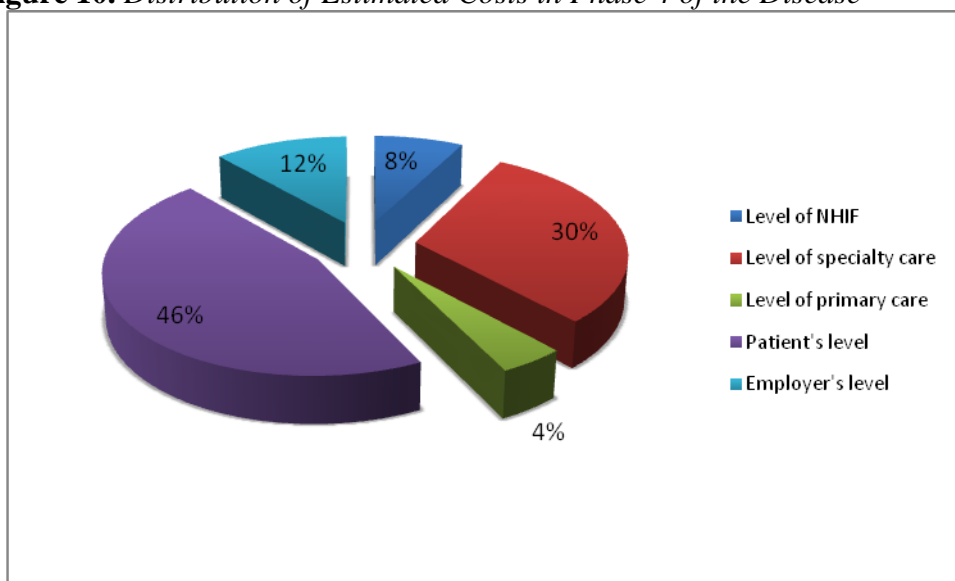
**Figure 9. Estimated Cost in Phase 4 of the Disease**



Source: Compiled by Research Team based on Cost Calculation



**Figure 10.** *Distribution of Estimated Costs in Phase 4 of the Disease*

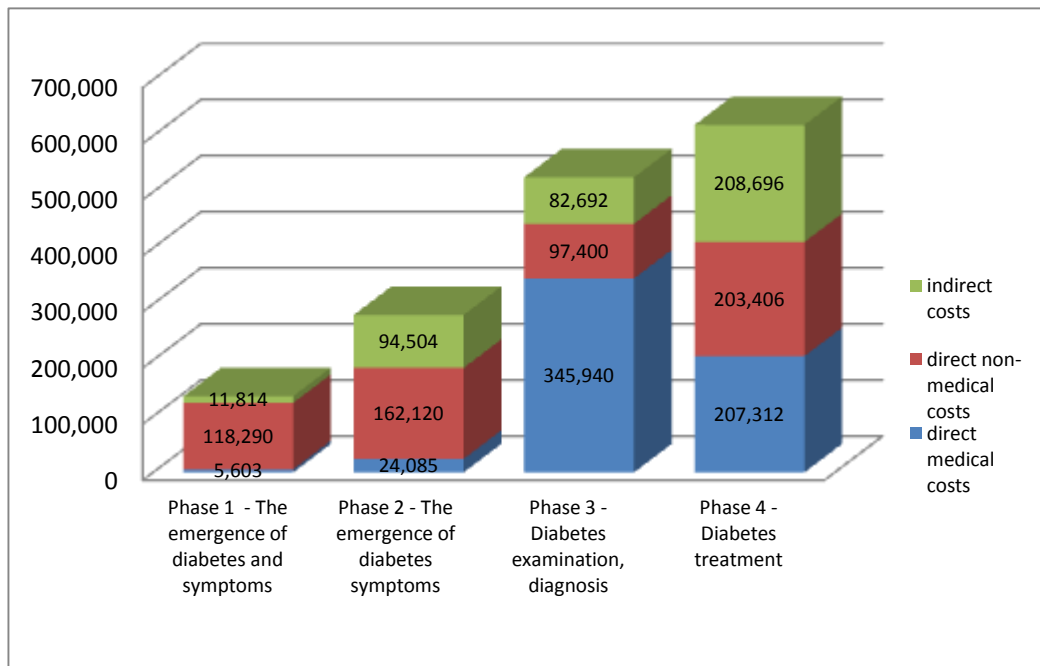


Source: Compiled by Research Team based on the Cost Calculation

### Summary

The costs of type 2 diabetes are fundamentally determined by the nature of the disease as well as the procedure followed in the treatment of its symptoms. The cost calculations of the 1-4 phases of diabetes are the same in three phases (phases 1, 2 and 4). The cost calculation for phase 3 differs to the extent that in this case we cannot define the costs per calendar year while we can define the costs of examination and of establishing the diagnosis. In the various phases, as the disease progresses, the related costs increase significantly. If we consider the phase in which symptoms emerge as a basis, the costs within the phase of diabetes treatment more than quadruple (*Figure 11*).

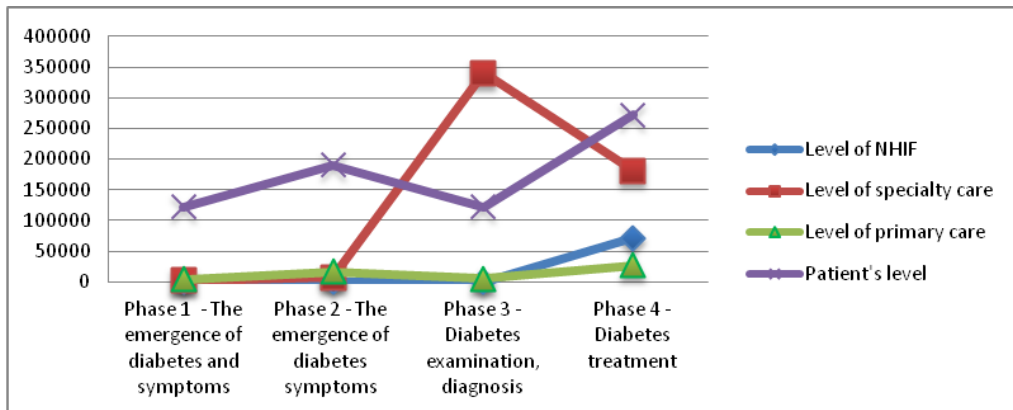
**Figure 11.** Diabetes Costs in Phases 1-4 of the Disease by Cost Type



Source: Compiled by Research Team based on Research Database

In phases 1-4 of the disease we estimated the total cost of HUF 1 495 709 per patient. 47% of the costs arise on the patient's level while the specialty care system, coming next, must also be considered as a major cost bearer. When examining the internal cost structures of the various phases, in phase 3 the cost percentage of nearly 65% related to specialty care diverges from the cost trends of the other phases (*Figure 12*).

**Figure 12.** Development of Diabetes Costs in Phases 1-4 of the Disease per Cost Centre



Source: Compiled by Research Team based on Research Database

The cost calculation completed estimated the annual costs of type 2 diabetes patients without complications considering year 2013 as the base year. Patient can rightly be considered as the main cost bearer of the disease.

The novelty of the research findings lies in the fact that similar cost estimations involving the patients' level with such depth have not been prepared in the topic in Hungary to this date.

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