

## INDIRECT COSTS OF ARTERIAL HYPERTENSION AND ITS COMPLICATIONS

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### Abstract

Arterial hypertension (AH) and related cardiovascular complications are considered to be a global factor of morbidity and mortality of the adult population. Every year, over 9 million people die prematurely due to arterial hypertension and its complications, of which about one third of patients are unaware of their illness.

The article presents a study on the indirect costs of hypertension and its complications in Poland. The analysis material comes from data obtained from the Social Insurance Fund (ZUS) and Statistics Poland (GUS) on the subject of GDP in 2016 -2017 and data on the percentage of working-age people and the general population for 2016 - 2017.

The total cost of absenteeism as a result of AH and its complications in 2016-2017 amounted to PLN 585,044,909.70.

The total cost of presenteeism as a result of AH and its complications in 2016-2017 was PLN 284,494,461.54.

Total indirect costs of informal care due to AH and its complications in 2016-2017– 30,386,446.74 PLN.

Total indirect cost of permanent or temporary incapacity to work due to AH and its complications in 2016-2017 was 3.834.367.026,86 PLN.

The final indirect cost of deaths in the amount of PLN 255,050,903.29 was obtained.

Taking into account all categories of indirect costs (absenteeism, presenteeism, informal care, permanent and partial incapacity to work and premature deaths), total indirect costs of AH and its complications in Poland in 2016 amounted to PLN 2,722,988,728.26, representing a loss of 0.14% of GDP on a yearly basis. The indirect cost of AH and its complications in 2017 amounted to PLN 2,621,405,923.16, representing a loss of 0.13% of GDP on a yearly basis

Key words: indirect costs; arterial hypertension

## Introduction

Arterial hypertension (AH) and related cardiovascular complications are considered to be a global factor of morbidity and mortality of the adult population [1,3,5,8,27]. Every year, over 9 million people die prematurely due to arterial hypertension and its complications, of which about one third of patients are unaware of their illness [17,8,22,27].

Hypertension is defined as a set of changes generated by a variety of genetic and environmental factors, leading to sustained systolic blood pressure (SBP) or diastolic blood pressure (DBP) values above 140/90 mm Hg measured clinically (Figure 1). [8]

Measurement method	SBP		DBP
at a medical practice	≥140	and/or	≥90
automatically (ABPM)			
24 h	≥130	and/or	≥80
During the day	≥135	and/or	≥85
At night/while sleeping	≥120	and/or	≥70
At home (HBPM)	≥135	and/or	≥85

**Fig. 1. Values of arterial pressure (mm Hg) defining hypertension depending on the measurement method**

Source: [15, p.11].

If blood pressure increases to 180/110 mmHg, immediate hospitalization is required due to the risk of a number of complications or death [8].

Hypertension is divided into two groups. There is a so-called secondary form of hypertension, where the increase in blood pressure is the result of a specific disease. Most often they are chronic kidney diseases, endocrine diseases or vascular diseases. The vast majority of hypertensive patients (over 95%) have the so-called primary form with undetermined etiology [8]. Thus, while in secondary forms, if a disease that is the cause of hypertension is found, the patient can be cured, in the primary forms it is impossible [8].

AH is a disease that has no known etiology - there are no generally recognized mechanisms that cause blood pressure to be permanently elevated. Probably these are mechanisms related to metabolic economy, physical activity, hormones and diet [3,8]. Currently, a much more important role in the development of AH is attributed to genetic rather than environmental factors. As research shows, about 20 to 40% of AH cases are genetically conditioned. The incidence rate is 15 to 57% in the case of one of the parents suffering from AH and as high as 44 to 73% when AH was diagnosed in both parents [24].

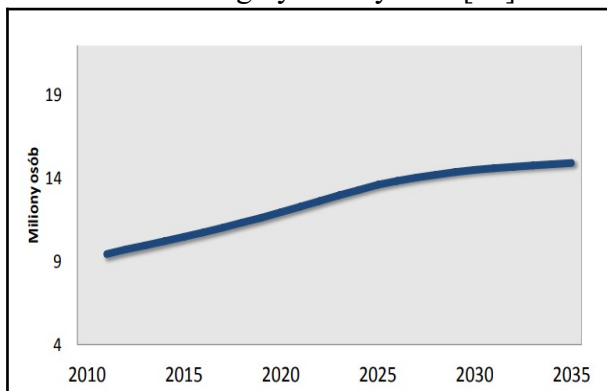
The clinical picture of AH without complications is not very characteristic and the symptomatology typical for this disease cannot be accurately determined. In the vast majority of cases, primary AH is rather asymptomatic. Patients diagnosed with AH report occipital headaches, frequent fatigue, sleep disturbances, palpitations at full rest, sensation of irritability, lack of concentration, nervousness [3,8].

Hypertension should be seen in the category of increased cardiovascular risk, which is an indicator that a patient is at risk of stroke, heart failure or a heart attack in a way that exceeds the norms for the population. Studies conducted over the last decades have shown that too high blood pressure has a direct linear relationship with the incidence of

cardiovascular disease, such as heart attack, stroke, heart failure, peripheral artery disease, as well as other ailments such as: kidney failure, even requiring renal replacement therapy and the risk of developing dementia [4, 18, 20].

The purpose of therapy for AH is to lower blood pressure below 140/90 mm Hg, and in patients who have additional risk factors, such as diabetes and chronic kidney disease - below 130/80 mm Hg [8, 17].

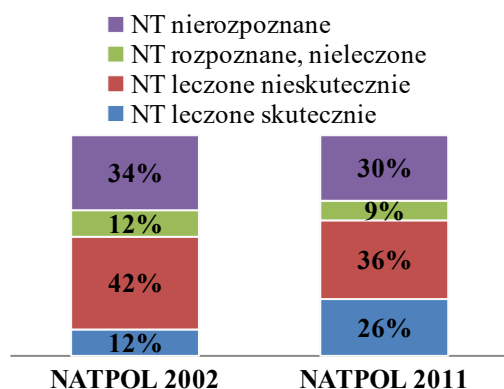
Despite significant advances in medicine in the area of hypertension, its detectability and treatment efficiency are still unsatisfactory. The latest NATPOL 2011 study shows that in Poland, 32% of adults have hypertension. This means that it is a group of at least 10 million people. There is an upward trend in this area, because the NATPOL PLUS 2002 study carried out almost 10 years ago indicated a 26% incidence rate for this disease. According to the NATPOL simulation, if this trend does not change, it may result in the number of patients with AH increasing by half by 2035 [12].



**Fig. 2. The forecasted change in the number of hypertensive patients in Poland in 2011-2035**

Source: [12, p.400].

AH detectability is observed at 70%, of which the percentage of patients with properly controlled AH is 26% of the total number of patients treated. It should be emphasized that, although the effectiveness of AH treatment is still at an unsatisfactory level, since 2002 there has been over a two-fold improvement in disease control (from 12% in 2002 to 26% in 2011) (Fig.3) [14].



**Fig. 3. Detectability and effectiveness of treatment of hypertension**

Source: [14, pp. 400-401]. (undiagnosed AH, undiagnosed and untreated AH, AH treated ineffectively, AH treated effectively)

Also, the results of the WOBASZ II study, conducted at the turn of 2013 and 2014, showed that in the 10 year period from the last WOBASZ I study conducted in 2003-2005, unfavourable changes in the prevalence of hypertension in the adult population are observed (Fig. 4) [1].

liczba czynników ryzyka*	badanie					
	WOBASZ I			WOBASZ II		
	płeć		razem	płeć		razem
	mężczyźni	kobiety		mężczyźni	kobiety	
	%	%	%	%	%	%
0	8,0	10,3	9,2	8,7	10,9	9,9
1	23,0	27,9	25,6	21,2	26,8	24,3
2	30,4	29,7	30,1	29,4	27,9	28,6
3	24,6	21,1	22,8	23,8	20,0	21,7
4	10,9	8,8	9,8	13,1	11,3	12,1
5	3,5	3,4	3,4	4,6	4,6	4,6
6	0,5	0,3	0,4	0,4	0,3	0,3

\* Otyłość, nadciśnienie tętnicze, hipercholesterolemia, cukrzyca, palenie i mała aktywność fizyczna

**Fig. 4. Comparison of the prevalence of selected risk factors in WOBASZ I and WOBASZ II studies (women and men aged 20-74)**

Source: [1, p. 52].

(number of risk factors, WOBASZ I study, sex, men, women, total, WOBASZ II study, sex, men, women, total

Obesity, arterial hypertension, hypercholesterolemia, diabetes, smoking and little physical activity

As the results show in Fig. 4, AH prevalence increased from 36% to 43%. Of which in men from 40.1% to 48.2%, while in women from 32.1% to 38.4%. Increased incidence of AH is accompanied by a higher incidence of obesity from 9.2% to 9.9% in both men (from 8% to 8.7%) and women (from 10.3% to 10.9%) and diabetes - from 9.8% to 12.1%, also in men (from 10.9% to 13.1%) as well as in women (from 8.8% to 11.3%) [1].

The results of treatment of hypertension are specific costs for the public health system resulting from the loss of productivity and reduced work efficiency due to the disease or drugs [6].

Poland is in the group of countries with the highest absenteeism due to sick leave in Europe, however, analysing the costs of therapy and medical costs in connection with indirect costs is at a marginal level [25].

Presentation of the results of deteriorated health of an individual for the economy is considered as the basic objective of analysing indirect costs, because the disease affects the ability to perform work. Through absence at work, productivity of an employee and production efficiency are reduced by a decrease in gross domestic product (GDP) [7]. The latest available comprehensive data relating to AH cost estimation shows that indirect costs are 26.6% of the total costs incurred for the treatment of hypertension, while the remaining 73.4% are medical costs [6, 21]. Considering that the number of hypertensive patients is increasing year by year, it is recognized that both the calculation of indirect costs of this disease and including them in the general measurement of costs incurred for treatment will allow for the recognition of needs to implement new solutions in coordinated care and saving

significant costs that may remain in the system or be intended for AH and cardiovascular disease treatment [28].

## Material and methods

The article presents a study on the indirect costs of hypertension and its complications in Poland. The analysis material comes from data obtained from the Social Insurance Fund (ZUS)<sup>1</sup> and Statistics Poland (GUS) on the subject of GDP in 2016 -2017<sup>2</sup> and data on the percentage of working-age people and the general population for 2016<sup>3</sup>-2017<sup>4</sup>.

The study was conducted by analysing indirect costs of hypertension and its complications, using the human capital method. This method is considered the most common and relatively easy to apply in practice [7].

The estimated indirect cost determined by means of the human capital method included: absenteeism, presenteeism, informal care, permanent incapacity to work and deaths resulting from AH.

Absenteeism was assumed as absence of an employee from work related to AH, where as a result of absence, the volume of production that he/she would be able to produce while remaining in full health is a resource loss from the point of view of the economy as a whole [7]. Presenteeism of AH patients was assumed as presence, despite the deteriorated well-being caused by the disease and the resulting lower work efficiency, compared to the work efficiency obtained by that employee in a situation where he/she is healthy [7]. On the other hand, informal care was assumed as all forms of informal care of an AH patient and providing assistance by people who do not professionally care and rehabilitate patients [7].

The following complications were assumed as AH complications: disease entities: I11- hypertensive heart disease, I12 - hypertensive kidney disease, I13- hypertensive heart and kidney disease, I21 - acute myocardial infarction, I64-stroke<sup>5</sup>, aneurysm- I71.

In accordance with the adopted method, the estimation of AH indirect costs was the product of the number of manhours not worked in the studied population of patients with AH due to the sickness, and the value, by which the production decreases due to the loss of one hour of work in the economy.

## Results

With the use of ZUS data on the number of medical certificates issued for AH, absenteeism for the years 2016-2017 was calculated.

In 2016, the length of absenteeism due to sick leave for AH and its complications amounted to 992,788 days of absence, which - in terms of years of work for a year having 250 working days was 3,971 working years.

In 2016, GDP in Poland amounted to PLN 1,861,112 million, which in relation to the number of employees at the level of PLN 15,180 people means GDP per one employee in the amount of PLN 121,949.90 annually. The product of this value and the number of lost years of work is PLN **314,783,012.10**.

After using the correction factor of 0.65<sup>6</sup> the final indirect cost of absenteeism due to

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1 The data included information on absenteeism due to sick leave and certificates issued for the disease entity I10 (spontaneous primary hypertension) and its complications I11, I12, I13, I14, I15.

2 Information on the socio-economic situation of the country in 2017, GUS, Warsaw, 29 January 2018.

3 Labor market in Poland in 2016, Ministry of Family, Labor and Social Policy Department of Labor Market, Warsaw 2017.

4 Labor market in Poland in 2017, Ministry of Family, Labor and Social Policy Department of Labor Market, Warsaw 2018.

5 In the data from ZUS for 2017, stroke is classified as I49. In the data for 2016 as I 64.

6 The indicator determined on the basis of §5 para. 7 of the Ordinance of the Minister of Health of April 2, 2012 on the minimum requirements that must be met by analyzes included in applications for reimbursement and

AH and its complications was obtained: PLN **1,874,049,166.9**.

In turn, the length of absence due to sick leave for AH and its complications in 2017 amounted to 1,131,522 days of absence. In total, in terms of years of work, it was 4,526 working years.

In 2017, GDP in Poland amounted to PLN 1,988,730 million. In view of the number of employees amounting to 15,749 people it means that GDP per employee was PLN 125,855.6 per year. The product of this value and the number of lost years of work resulted in **PLN 569,630,508.90**. After using the correction factor of 0.65, the final indirect cost of absenteeism in the amount of **PLN 370,268,788.60** was obtained.

The total cost of absenteeism as a result of AH and its complications in 2016-2017 amounted to PLN **585,044,909.70**[Tab.1].

Years	Number of lost years	Total number of employed people in thousands	Days of absence	GDP per 1 person/employee
2016	3,971.15	15,180	992,788	121,949.9
2017	4,526.08	15,749	1,131,522	125,855.6
<b>Indirect cost of absenteeism due to AH and its complications in 2016</b>				
484,281,724.8 x 0.65 = <b>314,783,121.10 PLN</b>				
<b>Indirect cost of absenteeism due to AH and its complications in 2017</b>				
569,633,520.9 x 0.65 = <b>370,261,788.60 PLN</b>				
<b>Total indirect cost of absenteeism due to AH and its complications in 2016-2017</b>				
<b>685,044,909.70 PLN</b>				

**Table 1. Indirect cost of absenteeism due to AH and its complications in 2016-2017**

Source: own study

### Presenteeism

Epidemiological data estimates the incidence of AH in the range of 9.5 million of the total population. There are 61.9% of AH cases for people at working age (from 15 to 64). According to Eurostat estimates for this age group, the share of the number of working people in 2016 in the total population is 69%. The product of the three above-mentioned values allowed us to determine that among the group of workers aged 15-64, 4,057,545 people suffer from AH.

On the basis of medical certificates issued in 2016 (250,763 certificates), it was found that in the group of people at working age, who suffer from AH, 3,806,782 do not take sick leave<sup>7</sup>. At the same time, based on a review of the literature, it was established that one case of presenteeism is a loss of 0.12 business day [32], which means that in 2016, as a result of AH, 1,706 years of work were lost. The value of this work, calculated by multiplying the annual GDP per employee in 2016, indicated a cost of **PLN 208,046,580.58**. Taking into account the correction factor of 0.65, the total cost of presenteeism due to AH and its

determination of the official sales price and an increase in the official sale price of a drug, foodstuff for particular nutritional purposes, a medical device that does not have a refund equivalent in a given indication.

<sup>7</sup>It is assumed that this group should include both cases of presenteeism in the strict sense, as well as cases of absence at work (or non-employment due to illness) by all people uninsured at ZUS. They include illnesses in the group of farmers and self-employed [7].

complications in 2016 amounted to **PLN135,300,755.7**.

Similarly calculated indirect cost of presenteeism for AH and its complications in 2017 was PLN 149,193,705.84.

The total cost of presenteeism as a result of AH and its complications in 2016-2017 was PLN 284,494,461.54 [Tab. 2].

2016	284,494,461.54	250,763	3,806,782	121,949.	1,706
2017	5,814,000	243,549	4,040,730	125,855.	1,822
<b>Total indirect cost of presenteeism for AH and its complications 2016</b>	<b>208,046,580.58 x 0.65 = 135,300,755.7 PLN</b>				
<b>Indirect cost of presenteeism for AH and its complications 2017</b>	<b>229,390,316.67x0.65=149,193,705.84 PLN</b>				
<b>Total indirect cost of presenteeism for AH and its complications in 2016-2017:</b>	<b>284,494,461.54 PLN</b>				

**Table 2. Direct cost of presenteeism as a result of AH and its complications in 2016-2017**

Source: own study

### Informal care

It is assumed that the estimation of indirect costs of informal care should be as in the case of estimating indirect costs of absenteeism, however, the basis for estimations should be data on the number of certificates issued for the care of a child or other family member. Due to the fact that the Social Insurance Fund does not have data on this subject, broken down into ICD-10 units, based on a review of the literature [7, p. 61], it was found that these estimates should be based on the assumption that the share of the total length of sick leave is the same as that for caring for a child or other family member [7, p. 61].

In 2016 992,788 days of sick leave due to AH and its complications constituted approx. 0.41% of the general duration of sick leave issued due to the patient's illness. Using the same percentage for 106,134 days of leave for care<sup>8</sup>, 43,514 working days were received translating into 174 years of lost work.

Considering that GDP per one employee in 2016 was PLN 121,949.93, the amount of PLN 21,219,287.82 was obtained.

After applying the correction factor of 0.65, the total indirect cost of informal care for AH and its complications in the amount of PLN 13,797,274.11 was obtained.

Similarly, calculating the indirect cost of informal care for AH and its complications for 2017, the amount of PLN 16,589,172.63 was obtained [Tab. 3].

The total indirect cost of informal care for AH and its complications in 2016-2017 was PLN 30,386,446.74.

<sup>8</sup> Total care for a child and a family member.

Year	Days of sick leave due to AH and its complications	Total number of days of absence due to care for a child or another family member	Sick leave duration percentage	Lost years of work	GDP per 1 person/employee
2016	992,788	106,134	0.41%	174	121,949.9
2017	1,131,522	110,210	0.46%	202	125,855.6
<b>Indirect cost of informal care due to AH and its complications in 2016</b>					
21,219,287.82 PLN x 0.65 = 13,797,274.11 PLN					
<b>Indirect cost of informal care due to AH and its complications in 2017</b>					
25,521,804.04 PLN x 0.65 = 16,589,172.63 PLN					
<b>Total indirect costs of informal care due to AH and its complications in 2016-2017– 30,386,446.74 PLN</b>					

**Table 3. Indirect cost of informal care due to AH and its complications in 2016-2017**

Source: own study

### Permanent or temporary incapacity to work

As in the case of estimating the costs of informal care, in the case of determining the cost of permanent or partial incapacity to work, there is no data broken down by individual IDC-10 units.

In order to estimate the scale of lost production due to incapacity to work due to AH, ZUS data referring to the number and amount of disability pensions paid by ZUS for cardiovascular diseases were used.

It is considered that an estimate of lost production based on the total number of disability pensions granted in a given year would be an excessive value [7].

Based on the review of the literature [18, p. 77], the average number of beneficiaries whose incapacity to work resulted from cardiovascular diseases was established. For this purpose, the share of the amount of expenses incurred for disability pensions due to cardiovascular diseases (taking into account the division into sex and degree of incapacity to work) was calculated in the amount of expenses incurred for disability pensions incurred for all disease entities (for a given sex and degree of incapacity to work), amounting to 0.11%.

It was also assumed that the same share of cases caused by AH and its complications can be attributed to the number of first-time disability pensions in each age group.

Considering the fact that regarding AH and its complications, the Social Insurance Fund (ZUS) does not have detailed data regarding the structure of partial and total incapacity to work, as well as pensions granted for a definite or indefinite period of time, the next assumption made on the basis of literature review referring to the estimation of indirect costs of diseases [7, p. 62] was the assumption that the share of the four groups distinguished above in the population of people incapable to work is the same as in the general population of people who were awarded pensions in 2016 for the first time. In addition, based on ZUS data, the average time of incapacity to work in the case of a pension granted for a definite time for cardiovascular diseases was 19.6 months in 2016. It was also assumed that a person who was declared partially incapable to work is able to work for 1/4 of full-time employment<sup>9</sup>.

<sup>9</sup> This assumption is consistent with the amount of the pension for partial incapacity to work, which is 3/4 of the pension for total incapacity to work. The pension is therefore reduced by 1/4.



The next step was to determine the path of future work efficiency, which was established based on GDP forecasts for individual time intervals [20]. It was pointed out that by 2020 the dynamics of labour productivity will increase to the level of 1.028% per annum. Then, it gradually decreases: from 2021 to 2030 to 1.022%, from 2031 to 2040 to 1.015%, and from 2051 to 2060 to 1.008%. The annual amounts of GDP per one employee were increased by the above indicators. The next step was to submit the obtained production growth path to two corrections: discounting<sup>10</sup> and multiplication by the probability of survival of a working person determined based on life expectancy tables of Statistics Poland for various age groups<sup>11</sup>.

For each age group to which ZUS applies the division into newly granted pensions (20-29, 30-39, 40-49, 50-59, 60-64) - based on the above-mentioned assumptions - the unitary loss of GDP for the inability to work was determined: i.e. permanent partial incapacity to work, permanent total incapacity to work, temporary partial inability to work, temporary total incapacity to work. The next step was to refer the values obtained to the frequency of the four categories of pensioners in 2016, and multiply them by the number of newly granted disability pensions in each age group. In this way, the total amount of indirect costs caused by permanent or temporary incapacity to work due to AH and its complications was received, amounting to PLN 3,083,163,131.94.

Multiplying the amount received by the 0.65 correction factor, the total indirect cost of permanent or temporary incapacity to work due to AH and its complications was obtained in the amount of PLN 2,004,056,674.06.

By making similar calculations for 2017, the indirect cost of permanent or temporary incapacity to work due to AH and its complications amounted to PLN 1,830,310,352.80.

The total indirect cost of permanent or temporary incapacity to work due to AH and its complications in 2016-2017 was 3.834.367.026,86.

### **Premature deaths**

Due to the lack of data relating to the number of deaths due to AH, Statistics Poland data including forecast statistics of deaths and mortality due to cardiovascular diseases were used [2].

Because the estimates of Statistics Poland are forecast for five-year periods, divided into age groups 0-64 and above 65 years [2, p. 27], in order to estimate the indirect costs of cardiovascular diseases, the last available data on the number of deaths in 2015 for the age group 0-64, amounting to 27,000.1 annually was assumed. At the same time, based on data on the probability of death according to a shortened life expectancy table, it was established that in 2015 the probability of death for the 0-64 age group, in total for women and men, was 0.038886. The indirect cost of cardiovascular diseases was calculated taking into account the value of GDP per employee, amounting to PLN 7,200.71 in 2015. The value obtained was multiplied by the employment rate at working age amounting to 51.9% in 2015 [29]. After applying the correction factor of 0.65, the final indirect cost of deaths in the amount of PLN 255,050,903.29 was obtained.

Taking into account all categories of indirect costs (absenteeism, presenteeism, informal care, permanent and partial incapacity to work and premature deaths), total indirect costs of AH and its complications in Poland in 2016 amounted to PLN 2,722,988,728.26, representing a loss of 0.14% of GDP on a yearly basis. The indirect cost of AH and its complications in 2017 amounted to PLN 2,621,405,923.16, representing a loss of 0.13% of GDP on a yearly basis (see Table 4 and Chart 1).

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10 A 5% growth rate was applied annually in accordance with the Regulation of the Minister of Health on minimum requirements.

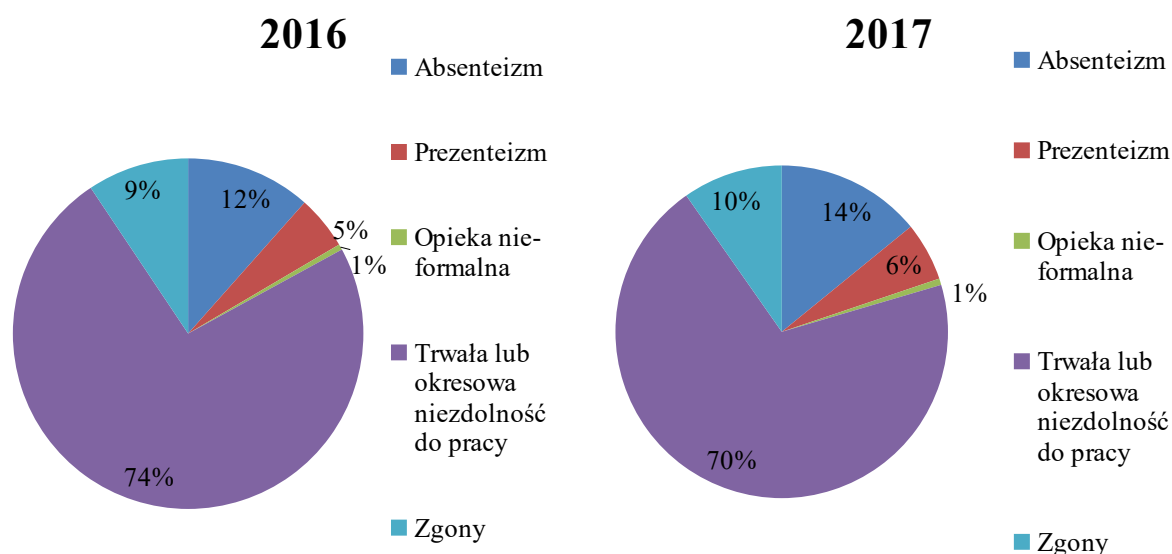
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Years	2016	Costs as %GDP	2017	Costs as %GDP	2016-2017
Absenteeism	314,783,121.1	0.017004274	370,261,788.6	0.018680278	685,044,909.7
Presenteeism	135,300,755.7	0.007308814	149,193,705.8	0.007527052	284,494,461.5
Informal care	13,797,274.11	0.000745315	16,589,172.63	0.000836949	30,386,446.74
Permanent or temporary incapacity to work	2,004,056.674.06	0.108257167	1,830,310,352.80	0.092341978	3,834,367,026.86
Deaths	255,050,903.29	0.01	255,050,903.29	0.01	510,101,806.58
<b>Total</b>	<b>2,722,988.728.26</b>	<b>0.14709</b>	<b>2,621,405,923.16</b>	<b>0.13225</b>	<b>5,344,394,651.42</b>

**Table 4. Indirect costs of AH in Poland in 2016-2017**

Source: own study

\*Costs do not include information on deaths in 2016 and 2017. The latest available data on this topic for 2015 was used.



**Chart 1. Structure of indirect costs of AH and its complications in 2016 and 2017**

Source: own study

\* Costs do not include information on deaths in 2017. The latest available data on this topic for 2015 was used

Absenteeism, Presenteeism, Informal care, Permanent or temporary incapacity to work, Deaths

While analysing the individual components of indirect costs in a given year, it should also be noted that the highest percentage of indirect costs is the cost of permanent or

temporary incapacity to work: 73.60% in 2016 and 69.82% in 2017 (see Table 5).

Years	2016	% total	2017	% total	2016-2017
<b>Absenteeism</b>	314,783,121.1	11.56	370,261,788.6	14.12	<b>685,044,909.70</b>
<b>Presenteeism</b>	135,300,755.7	4.97	149,193,705.8	5.69	<b>284,494.461.5</b>
<b>Informal care</b>	13,797,274.11	0.51	16,589,172.63	0.63	<b>30,386,446.74</b>
<b>Permanent or temporary incapacity to work</b>	2,004,056,674.06	73.60	1,830,310,352.80	69.82	383,436,726.86
<b>Deaths</b>	255,050,903.29	9.37	255,050,903.29	9.73	510,101,806.6
<b>Total</b>	2,722,988,728.26	100	2,621,405,923.16	100	5,344,394,651.42

**Table 5. Percentage share of individual components of indirect costs in 2016-2017**

Source: own study

\* Costs do not include information on deaths in 2016 and 2017. The latest available data on this topic for 2015 was used.

The indirect cost related to absence from work due to AH and its complications per patient per year in 2016<sup>12</sup> amounted to PLN 671.09, while in 2017<sup>13</sup> - PLN 450.87. The decrease in indirect costs of AH and its complications in 2017 can be attributed to the use of data on deaths for 2015 as well as the decrease in the cost of permanent and temporary incapacity to work.

Analysing the costs of lost productivity, it should be taken into account that due to the lack of data on AH, the above calculations were based on the adoption of some simplifying assumptions, e.g. on the use of general data on cardiovascular diseases, or estimation of data on deaths based on the latest available data.

## Discussion

Treatment of AH and its complications generate high direct and indirect costs. This fact is determined by the need for long-term, chronic treatment of a large group of patients - from the moment of diagnosis to the patient's death.

The results of the analysis showed that the indirect cost of treatment of AH and its complications in 2016 was estimated at PLN 2,722,988,728.26, which gave the amount of PLN 671.0 per patient per year. Most of these costs were the costs of permanent or temporary incapacity to work amounting to 73.60% of total indirect costs in 2016. Similarly, in 2017, despite the decline in the total indirect costs as compared to 2016 by 3.73%, expenses related to loss of work efficiency and sick leave per patient per year were 450.87%.

The obtained results were compared with the results of other authors' research.

In comparison with the results obtained in 1999 on the basis of the PENT study, the indirect cost of AH per patient per year was PLN 418 (26.6% of total costs of treatment of AH), which was a loss of 0.4% of GDP<sup>14</sup> [6].

<sup>12</sup>Considering the number of people suffering from AH in the group of professionally active people in 2016-4,057,545

<sup>13</sup>Considering the number of people suffering from AH in the group of professionally active people in 2017 - 5,814,000.

<sup>14</sup> Considering that the total cost of treatment of AH and its complications in 1999 amounted to PLN 14 billion,

Similar values were obtained in the study conducted by Paczkowska et al. [13]. The annual indirect cost of treatment of AH per patient in 2010 amounted to PLN 583.2 (2% of the total costs of treatment of AH), representing a loss of 0.17% of GDP<sup>15</sup>.

The results of our own study were also compared with the results of similar analyses regarding the assessment of indirect costs related to the occurrence of AH conducted in the United States and Sweden. It is worth mentioning here that the United States is a country where the prevalence of AH is 5%<sup>16</sup> of the population and indirect costs of treatment of AH and its complications are estimated at 135 billion USD per year [6]. In addition, it is a country for which comparisons of research results are often formulated [6].

In contrast, Sweden is a European country with a well-organized system of health care, financed from public funds [6, 13], where the prevalence of AH is estimated at around 1 million of the total population of 8.8 million people [6]. It is also emphasized that in both countries, health policy makers include arguments based on the results of economic analyses in the area of treatment of AH and its complications [6].

It should also be pointed out that international comparisons are based on significant differences, both in the health care system and in the socio-economic situation.

Referring the results of the author's own study to the results of studies conducted in 2003 in the USA, the annual indirect cost of treatment of AH for American patients is estimated at USD 7 billion (which is 18.8% of the total AH treatment costs of USD 37.2 billion) [22]. The indirect cost of AH treatment in 2003 in the USA was related to a loss of 0.60% of GDP<sup>17</sup>. In turn, taking into account indirect costs of treatment of AH complications in the USA, in 1994 they were estimated at USD 128 billion, which means a loss of 1.75 GDP<sup>18</sup>.

The total costs of treatment of AH and its complications in Sweden were estimated at SEK 1,600 million (about USD 167<sup>19</sup> million) [6]. Indirect costs accounted for 8% of total costs, which gave the amount of SEK 128,000.00 (USD 13,344.66). Referring the above amount to GDP in Sweden<sup>20</sup> represented a loss of 4.7% of GDP<sup>21</sup>. If we take the absolute value of costs in PLN<sup>22</sup>, then the indirect cost of AH treatment would mean a loss of 0.004% of GDP. It can be assumed that the definitely lower share of indirect costs of AH treatment in Sweden is associated with both a lower AH incidence in Sweden of about 11%, in Poland about 32%, as well as a lower percentage of indirect costs incurred by the healthcare system - in Sweden 8% in Poland 18.8%.

In addition, comparing the results of the author's study relating to the determination of

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and indirect costs accounted for 26.6% of this amount (PLN 3,724 million), compared to GDP in 1999 - PLN 792,111.8 billion PLN, indirect cost of AH and its complications amounted to 0.4% of GDP.

15 The value of GDP in 2010 amounted to PLN 1,435.4 billion. The incidence of AH in 2010 in Poland was estimated at 32% [10]. With the population of Poland at the level of 38.53 million, the number of people suffering from AH in 2010 amounted to 8,861.9 million, of which cases of people suffering from AH are 4,133,961.14 (cases of AH in 2010, x people aged from 15 to 64 years: 64.7% x, the share of the number of employed persons in the total population for this age group: 72.1%), The indirect cost amounted to PLN 2,410,926,139.9, which represents a loss of 0.17% of GDP.

16 In 1994, the US population was 263.4 million

17 US GDP in 2003 was 11.51 trillion dollars. The indirect cost of treatment of AH in the same year was 7 billion dollars.

18 GDP in the US in 1994 was 7.309 USD trillion. The indirect cost of AH complications was estimated at USD 128 billion.

19 Assuming the NBP exchange rate as of 03.05.2019 1SEK = 0.1046 USD).

20 According to the World Bank data, USD 280.3 billion (SEK 2,678 billion) 1USD - SEK 9.5560 as of 03.05.2019.

21 If the indirect cost of AH (USD 13,394.66 related to GDP in Sweden in 2017 (USD 538 billion), this cost would be 2.37% of GDP.

22 If the indirect cost of AH (USD 13,394.66 related to GDP in Sweden in 2017 (USD 538 billion), this cost would be 2.37% of GDP.

indirect costs per patient per year, in Poland it was: in 2016 -175,66 USD, and in 2017 - 118.02 USD<sup>23</sup>. In Sweden, the cost was USD 27.04 (SEK 258.23)<sup>24</sup> [6], while in the United States it was USD 82 [6].

The above data shows that indirect costs of AH and its complications per patient per year are considerably higher in Poland. This situation results from the appropriate allocation of increased funds for pharmacological treatment of patients with AH in Sweden and the United States [6], which contributes to a significant reduction in social and systemic expenses related to the incidence of AH and thus eliminating complications resulting from AH [6,13].

At the same time, it can be assumed that proper allocation of costs to pharmacological treatment may contribute to lower indirect costs borne by the state in connection with the incidence of AH and to improve the effectiveness of antihypertensive treatment, which is also confirmed by the results of studies carried out by many authors [3,5,13,21,22].

The lack of regularity of the use of drugs by patients with AH contributes to the decrease in the desired level of AH control, and thus an increase in direct as well

and indirect costs, in particular referring to the increase in organ related complications associated with AH [22].

## Conclusions

Summing up, it should be pointed out that arterial hypertension despite the improvement of treatment efficiency and the increase in financial resources allocated to antihypertensive therapy is still a serious economic problem, especially in the reduction of population productivity and a challenge for the public health system in terms of coordinating public expenditure on the treatment of this disease.

It is recommended to conduct interdisciplinary studies in the field of improving the effectiveness of treatment of arterial hypertension in relation to the rationalization of costs of this disease, as well as counting and taking into account indirect costs of arterial hypertension and its complications in the identification of needs and implementation of new medical technologies and new solutions in the coordinated care for AH patients.

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23 According to the exchange rate as of 03.05.2019 1 PLN – 0.2617 USD.

24 According to the exchange rate as of 03.05.2019 1 SEK - 0.1047 USD.

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