**Koc Martyna, Szumiał Szymon, Czerw Aleksandra. Indirect costs of chronic N18 kidney disease in Poland. Journal of Education, Health and Sport. 2019;9(5):232-240. eISSN 2391-8306. DOI**
**http://dx.doi.org/10.5281/zenodo.2900188**
**http://ojs.ukw.edu.pl/index.php/johs/article/view/6915**

**The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).**
**1223 Journal of Education, Health and Sport eISSN 2391-8306 7**



**The authors declare that there is no conflict of interests regarding the publication of this paper.**

**Received: 28.04.2019. Revised: 28.04.2019. Accepted: 18.05.2019.**

# Indirect costs of chronic N18 kidney disease in Poland

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Abstract
The article presents the estimation of indirect costs of chronic N18 kidney disease in Poland.
Research methods: The presented estimates were based on the human capital method. They concern the costs of absenteeism, presenteeism, informal care, permanent or temporary incapacity to work and deaths.
Results: The total indirect cost of chronic renal failure was 281,134,988,528.50 PLN.
Conclusions: The indirect costs of chronic kidney disease in Poland are high, especially in terms of presenteeism. This result is consistent with the data obtained in other countries. Building cost awareness and enabling patients to be professionally active with flexible work schedules seem to be particularly important. The availability of more accurate data would allow for more accurate estimates of indirect costs of CKD and other chronic diseases in the future.

Keywords: chronic kidney disease, cost analysis, indirect costs.

**Background**

Chronic Kidney Disease (CKD), a disease marked with the N18 code in ICD-10, according to the KDIGO 2012 (Kidney Disease Improving Outcomes) guidelines is defined as abnormalities in the renal structure or function relevant to health that persists for over 3 months.

The degree of severity of chronic kidney disease is determined by the values of GFR and albuminuria. GFR is estimated based on the serum creatinine concentration, whereas albuminuria - based on the albumin/creatinine index in any urine sample or on the basis of the daily loss of albumin in the urine. The clinical picture depends on the severity of chronic kidney disease and the underlying disease. Stage classification of chronic kidney disease: stage 1 – GFR ≥ 90/ml/min/1.73m2; stage 2 - slight decrease GFR 60-89 ml/min/1.73 m2; stage 3 - GFR 30–59 ml/min/1.73 m2, creatinine 130–350 μmol/l (1.5–4 mg/dl); stage 5 - GFR <15 ml/min/1.73 m2, SNN (uraemia).

With the decrease of glomerular filtration rate (GFR), symptoms and complications concerning various organs and systems appear[1] [2]. The most common causes of chronic kidney disease are diabetic kidney disease (diabetic nephropathy), glomerulonephritis or other glomrulopathy, kidney damage as a result of hypertension (hypertensive nephropathy) and atherosclerosis, acute kidney injury, tubulointerstitial kidney disease, e.g. pyelonephritis, and in children - congenital or acquired defects of the urinary tract causing kidney failure. The less common causes include obstructive nephropathy, connective tissue systemic diseases, including systemic lupus erythematosus, rheumatoid arthritis, vasculitis, sarcoidosis, amyloidosis, multiple myeloma, haemolytic-uremic syndrome, Alport syndrome and HIV nephropathy. Renal diseases cause gradual loss of nephrons due to hyperfiltration. The glomeruli become hypertrophic; and then, hardening and fibrosis of the interstitial tissue occur. The result is impaired renal function. As GFR decreases in the blood, uremic toxins accumulate, i.e. products of protein metabolism, which leads to an increase in serum concentration of creatinine, urea and uric acid. The production of erythropoietin by the kidneys is reduced, leading to anemia[3].

Chronic renal failure is one of significant socio-economic problems in addition to cardiovascular, respiratory and digestive disorders. Access to epidemiological data is limited. It is known, however, that currently, in the world 500-600 million people suffer from chronic renal failure. It is estimated that it is about 10-11% of the world's population[4]. According to the data of Statistics Poland, in 2016 there were 38,433,000 inhabitants in Poland, therefore in Poland the problem concerns 4 million people. Patients die mainly due to cardiovascular complications and infections. The mortality rate of patients treated chronically is 10-15%[5].

1 „Interna Szczeklika 2017" Piotr Gajewski, Andrzej Szczeklik „Przewlekła choroba nerek" [Chronic kidney disease], Michał Myśliwiec, Medycyna Praktyczna, Kraków 2017, p. 1532

2 Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Kidney inter., Suppl. 2013; 3: 1-150

3 „Interna Szczeklika 2017" Piotr Gajewski, Andrzej Szczeklik „Przewlekła choroba nerek" [Chronic kidney disease], Michał Myśliwiec Kraków 2017, pp. 1532 - 1543

4 „Przewlekła choroba nerek – dziesięć lat w praktyce i teorii" [Chronic kidney disease – ten years in theory and practice], Bolesław Rutkowski, Katedra i Klinika Nefrologii Transplantologii i Chorób Wewnętrznych Gdańskiego Uniwersytetu Medycznego, Forum Nefrologiczne 2013, vol. 6, no. 1, 63–70

5 „Interna Szczeklika 2017" Piotr Gajewski, Andrzej Szczeklik „Przewlekła choroba nerek" [Chronic kidney disease], Michał Myśliwiec, Medycyna Praktyczna, Kraków 2017, p. 543

## Material and method

Indirect costs presented in the pharmacoeconomic analysis were estimated using the human capital method[6]. The use of this method is supported by its grounding in economic theory and the relative ease of its application in practice. Indirect costs include absenteeism - loss of production, resulting from the absence of the patient at work; presenteeism - reduction of productivity related to malaise or disease of the person present at work; loss of production due to permanent incapacity to work; loss of production, which is caused by death and costs of informal care.

Calculations were based on data obtained from the ZUS (Social Insurance Company) Statistical Portal, Eurostat and Statistics Poland. In the absence of data, reasonable assumptions were made, or the values derived from empirical studies were used.

## Results

### Absenteeism

In order to assess the value of production lost as a result of absenteeism, data from the ZUS Statistical Portal on sick leave of employees in respect of their disease in 2016 was used. The total number of medical certificates issued due to chronic renal failure with the N18 code according to ICD-10 amounted to 7,295 and covered 139,363 working days of sick leave, that is 557 working years - assuming that there are 250 working days a year.

As a measure of productivity, GDP per one employee was assumed, which in 2016 amounted to 121,046.95 PLN. Then, by multiplying the number of lost years of work by the value of GDP per working person, the total loss of production as a result of absenteeism amounted to 67,423,151.15 PLN. In order to obtain the final result, a correction factor of 0.65 was applied. As a result, the indirect cost of sick leave as a result of the incidence of chronic renal failure was 43,825,048.25 PLN[7].

### Presenteeism

Chronic kidney disease belongs to a group of chronic diseases, consequences of which can be felt every day throughout life. It is estimated that the reduction in work efficiency depends on the stage of the disease and is on average 7.4% for stage 1 to 3 and 18.8% for stage 4 to 5[8]. Assuming that the distribution of individual classes is even, an estimate of 11.96% can be adopted. The patient's performance is reduced on average by approximately 86 hours of work per year, or 10.75 days[9].

Because the prevalence of chronic kidney disease is estimated at 10-11% of the world's population, in Poland the problem of chronic kidney disease affects 4,000,000 people. Share of the number of employees in the total population in 2016 remained at 56.2%[10]. The product of these two values indicates 2,248,000 cases of chronic renal failure among working people.

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6 Hermanowski, T. (2013). Szacowanie kosztów społecznych choroby i wpływu stanu zdrowia na aktywność zawodową i wydajność pracy [Estimation of the social costs of the disease and the impact of the health condition on professional activity and work efficiency]. Wolters Kluwer: Warszawa.

7 The author's calculations based on data from http://psz.zus.pl/

8 „Real-world costs of autosomal dominant polycystic kidney disease in the Nordics", Daniel Eriksson, Linda Karlsson, Oskar Eklund, Hans Dieperink, Eero Honkanen, Jan Melin, Kristian Selvig, Johan Lundberg; Eriksson et al. BMC Health Services Research (2017) 17:560 DOI 10.1186/s12913-017-2513-8

9 „The social cost of chronic kidney disease in Italy" Giuseppe Turchetti, S. Bellelli, M. Amato, S. Bianchi, P. Conti, A. Cupisti, V. Panichi, A. Rosati, F. Pizzarelli; Eur J Health Econ (2017) 18:847–858 DOI 10.1007/s10198-016-0830-1

10 Based on Popularion economic Activity Survey [Badanie Aktywności Ekonomicznej Ludności BAEL] http://stat.gov.pl/obszary-tematyczne/rynek-pracy/pracujacy-bezrobotni-bierni-zawodowo-wg-bael/

Considering the previously indicated 10.75 days of reduced productivity during the year, it should be noted that people with chronic renal failure experienced 24,166,000 days of lost productivity. According to the calculations presented in the section on absenteeism, in total patients took 139,636 days of sick leave. The total number of days during which people felt worse, but they were still at work constitutes the difference in the total number of days of lost productivity and the total number of days of sick leave and it amounts to 24,026,637 days. However, the loss of productivity during these days was not a total loss - it was only 11.96%. Multiplication of this estimation by the number of days during which people who were sick were still at work, despite worse well-being, resulted in 2,873,585.785 days. Assuming that in a year there are 250 working days, the result was 11,494.3314 lost years of work.
In order to obtain the final result, a correction factor of 0.65 was adopted and the value of GDP per one employee was used. As a result, the indirect cost resulting from presentism of patients with chronic renal failure was PLN 904,380,866.64[11] [12].

**Informal care**

Data on the number of days of absence due to care for a child and another family member, broken down into ICD-10 classification units, is currently not available on the ZUS Statistical Portal. Estimation of the cost of lost production due to informal care was made on the basis of data on the total number of medical certificates for care and the assumption that the share of the total length of sick leave due to care in the case of chronic renal failure in all medical certificates due to care is the same as the corresponding share in the case of medical certificates for employees' sickness. The total number of days of sick leave for all diseases in 2016 was 238,659,822 days, of which 139,363 sick leave days due to chronic renal failure amounted to approximately 0.058 per cent. On the other hand, the total number of days of leave due to care amounted to 9,809.17 thousand days. Thus, the number of working days for informal care due to the incidence of chronic renal failure was - based on the above assumptions – 5.689.3 days, which corresponded to 22.7 lost years of work. By multiplying the number of lost years of work by the value of GDP per one employee and a correction factor of 0.65, the final indirect cost resulting from informal care for a patient suffering from chronic renal failure amounting to PLN 1,790,548.27 was obtained[13].

**Permanent or temporary incapacity to work**

Due to the lack of ZUS data on the number of disability pensioners and newly granted disability pensions broken down into individual units of ICD-10 classification, the consequences of permanent and periodic incapacity to work due to chronic kidney disease were estimated on the basis of data on the expenditure of the Social Insurance Fund for disability pensions.
The following assumptions regarding the structure of disability pensions regarding partial and total incapacity to work as well as timely and indefinitely granted disability pensions were adopted. A person with partial incapacity to work is able to work for 0.25 time of work, which is consistent with the amount of benefit reaching, as a rule, 75% of the amount of disability pension due to total incapacity for work. The average time of incapacity to work in the case of a temporary disability pension granted in the group of patients diagnosed with diseases of the genitourinary system (N00 - N99) according to the ZUS data is equal to 19.1 months
The value of disability pensions due to incapacity to work as a result of diseases of the genitourinary system (N00 - N99) in 2016 amounted to PLN 652,079.80 (the most recent

11 The author's calculations based on data from http://psz.zus.pl/

12 The author's calculations based on data from https://www.stat.gov.pl/

13 The author's own calculations based on data from http://psz.zus.pl/

available data) and it accounted for 4.3% of all disability pensions paid from the Social Insurance Fund. It was assumed that the same proportion of cases caused by CKD can also be attributed to the number of newly granted disability pensions in each age group. In the absence of more precise data regarding chronic renal failure, it was assumed that the share of particular age groups in the population of people incapable to work due to CKD are the same as in the case of the general population of new disability pensioners in 2016. Disability pensions granted for an unlimited period in the category of genitourinary system diseases constitute 8.6% of all disability pensions granted. The total number of decisions determining the degree of incapacity to work, including the inability to live independently, total incapacity to work and partial incapacity to work is 2,228. The average time of incapacity to work in the case of a temporary disability pension of 19.1 months was multiplied by the number of decisions issued regarding partial incapacity to work, which resulted in 53,334,561.81. The same happened in the case of total incapacity to work, which resulted in 140.633.394.85. Disability pensions granted for an unlimited period regarding both, the partial and total incapacity to work costed 183.273.892,85. In each case the estimated time of professional activity was computed for each age group, annual potential GDP growth rate projection[14] for Poland was adopted and the discount rate of 5% was used.
In order to obtain the final result, a correction factor of 0.65 and the value of GDP were used. An indirect cost of PLN 245,207,202.20 was obtained[15] [16].

**Deaths**
Chronic Kidney Disease N18 is on the list of causes of death considered as "garbage codes", which follows WHO guidelines. Garbage codes correspond to descriptions of health conditions and diseases that make it impossible to precisely determine the cause of death. The number of deaths with CKD recognized as a cause in 2016 in Poland was equal to 203.
The data divided into age groups are not available from Statistics Poland.
In order to estimate the annual cost of deaths attributable to CKD the mean length of life in Poland was used. In 2016 it was equal to 40.85, which on average translates into 23.15 of professional activity and total sum 2.369.849,51 PLN of projected GDP per capita after applying 5% discount rate. It was corrected with regard to the percentage of working people at working age (56.2% according to BAEL in 2016) and the correction factor of 0.65 and then multiplied by the number of deaths caused by the CKD. The result was equal to 175,738,323.30 PLN[17,18,19.].

The table 1 presents summary of all types of costs involved.

Table 1
*Indirect costs of chronic N18 kidney disease in Poland*

| Costs | Amount |
|---|---|
| Absenteeism | 43,825,048.25 PLN |
| Presenteeism | 904,380,866.60 PLN |
| Informal care | 1,790,548.27 PLN |
| Permanent or temporary incapacity to work | 245,207,202.20 PLN |

14 The 2050 Ageing Report - Underlying Assumptions and Projection Methodologies, European Economy 8/2014.
15 The author's own calculations based on data from http://psz.zus.pl/
16 https://www.stat.gov.pl/index.php
17 The author's own calculations based on data from http://psz.zus.pl
18 Obliczenia własne na podstawie danych https://ec.europa.eu
19 https://www.stat.gov.pl/index.php

| | |
|---|---|
| Deaths | 175,738,323.30 PLN |
| Total | 1.370,941,988.66 PLN |

**Discussion**

The pattern of morbidity and mortality from diseases around the world varies both in developed and developing countries. In the 20th century, infectious diseases were the main cause of death and disability. However, in this century, non-infectious diseases have become the leading cause of death and morbidity in the world. This change is reflected in the type of diseases causing chronic renal failure as well as in their presentation and progression. One of the causes of end-stage kidney failure is diabetes as a result of global type 2 diabetes pandemic. The pace of progress is extraordinary, and it is expected that the number of patients with type 2 diabetes around the world will double in the next 25 years. This will lead to a corresponding increase in the number of patients with chronic kidney disease.

It is a huge challenge to provide information on the scale of diabetic, cardiovascular and chronic kidney problems to communities and governments around the world. The International Nephrology Society responds to this challenge by creating partnerships with other relevant associations, such as the International Diabetes Federation, with agencies and foundations such as the World Health Organization, the World Bank and the Rockefeller Institute to influence global and national health policy and policy makers in reference to the magnitude of the problem with chronic diseases. It will also require an agreed approach from individual physicians, nephrologists, diabetologists and physicians specializing in cardiovascular medicine. In order to avoid the huge problem of chronic diseases, detection and prevention programs should be implemented, including community research for diabetes, hypertension and chronic kidney disease. Lifestyle changes, modifications of negative consequences of globalization and mass community education will be essential. The Hong Kong Prevention Congress is one of the initiatives aimed at providing an interdisciplinary approach to the problem of chronic diseases, especially in the Asia-Pacific region. The problem is present in literature published all over the world[20].

Many people at working age diagnosed with CKD continue to work. However, they are people at risk of losing their job[21]. Between 2006 and 2014, 68,341 people suffering from CKD lost their job six months before entering into the end stage of the disease. Performing work in the case of people suffering from CKD is difficult because symptoms include fatigue, headaches, nausea, muscle cramps, shortness of breath and sleep problems. All of these factors can interfere with work and lead to a decrease in productivity[22]. Reduced renal function is also associated with a lower level of employment, especially in the group of people with GFR <50. Full-time employment is higher in the case of people with reduced GFR (mean serum, creatinine 5.4 mg / dL, 69%) in comparison to patients with renal insufficiency with an average serum creatinine value (13.7 mg / dL, 12%). Dialysis and transplant patients with diabetes report work-related problems more frequently than dialysis and transplant patients without diabetes[23].

20 „The epidemiology of chronic kidney disease" Robert C. Atkins, Department of Nephrology, Monash Medical Centre, Clayton, Victoria, Australia, Kidney International Volume 67, Supplement 94, April 2005, S14-S18

21 https://www.aakp.org/press-release/independence-workers-chronic-kidney-disease-means-keeping-job-avoiding-disability/

22 https://www.kidneyworks.org/chronic-kidney-disease-and-employment/

23 "Clinical Practice Guidelines for Chronic Kidney Disease: evaluation, classification and stratification" Andrew S. Levey, Josef Coresh,2002 National Kidney Foundation, Inc, page 192

Kidney disease is expensive and debilitating, but if there is no need for dialysis, it does not necessarily mean permanent disability. Having a job that provides coverage for health care costs can ensure that patients remain efficient employees, can achieve their goals, achieve better results, have contact with the family as well as function in society.
One of the early complications is anemia characterized by low levels of hemoglobin, an oxygen transporting protein found in red blood cells, because kidneys play an important role in their production process. Symptoms include fatigue, lack of energy, problems with concentration and memory, shortness of breath, dizziness, headache and chest pain. Consequences of anemia can be felt more severely when a person performs physical work. Symptoms of anemia can appear early. Approximately 30% of patients with diagnosed anemia feel tired and have low energy levels at stage 3 and 50% at stage 4[24]. A solution that would keep people chronically ill on the labor market could be the introduction of flexible work schedules. However, analyzes of contemporary labor markets in affluent countries signaled a polarization tendency, with a growing pool of employees who struggle with unpredictable and inflexible working time regimes, and a smaller group of privileged employees benefiting from greater space-time autonomy, although often with long working hours (Standing, 2011).
Working conditions in which people with chronic diseases are engaged in paid employment pose a challenge to the logic of contemporary capitalist economies, where flexibility is first and foremost a privilege of capital[25].
About 2-3% of health care expenditures in developed countries are used to provide treatment for patients with end-stage kidney disease. The economic costs associated with milder forms of chronic kidney disease are even higher. In the United States, Medicare expenditures on patients with chronic kidney disease in 2007 exceeded 60 billion USD, which accounted for 27% of the total budget. Acute kidney damage costs a lot more than 10 billion USD a year. The Australian Institute of Health and Welfare estimates that total health expenditures on chronic kidney disease in 2000-2001 amounted to 647 million AUS. The estimated cost of chronic kidney disease in the UK in the national health service in 2009-2010 was 1.44-1.45 billion GBP, which is about 1.3% of all health expenditures. More than half of this amount has been spent on renal replacement therapy. Most people in developing countries do not have access to insurance. A hemodialysis session costs USD 100 in Nigeria. This amount is twice as small as the minimum monthly salary of a federal government employee. The annual cost of dialysis treatment in China is approximately USD 14,300 per patient. Although the Chinese government plans to introduce insurance systems, patients in rural areas will still have to pay 35-45% of costs, which will be impossible for most people. Care for patients who have experienced an advanced stage of the disease for the first time can lead to catastrophic health expenditures in countries where patients have to pay for treatment themselves. Patients often travel long distances with families to receive specialist help. In addition, complications that require quick help are present at the end stage of the disease. The financial analysis carried out in India showed that 82% of patients experienced a financial crisis during treatment and about 56% of patients lost their jobs.
In the Global Burden of Disease 2010 study, chronic kidney disease ranked 27th on the list of causes for the total number of deaths in the world. The overall increase in premature mortality due to CKD was 82% and was the third largest, just behind HIV and AIDS (96%) and

24 "A job retention program for people with chronic kidney disease (CKD)" by the American Association of Kidney Patients (AAKP) and The Medical Education Institute (MEI),

25 „Integrating paid work and chronic illness in daily life: A space-time approach to understanding the challenges" Julia McQuoid, Jennifer Welsh, Lyndall Strazdins, Amy L. Griffin, Cathy Banwell; Health & Place Volume 34, July 2015, Pages 83-91

diabetes (93%). The data analysis of causes of death in the USA and Australia showed that a significant proportion of people who died of diabetes suffered from chronic renal failure, however diabetes without complications was reported as the cause of death. Reported mortality due to kidney disease associated with diabetes was estimated at four to nine times less than the actual value [26]. Data from 2016 show a doubling of the number of deaths from chronic kidney disease between 1990 and 2016[27].

Considering five categories of indirect costs (presenteeism, absenteeism, informal care, incapacity to work and deaths), total indirect costs of chronic kidney disease in Poland in 2016 amounted to PLN 1,370,941,988.66. It should be borne in mind that - due to data gaps - the above calculations were made based on simplifying assumptions. As a result, the values presented constitute only an approximation of the actual indirect cost generated by the incidence of chronic renal failure. Keeping more accurate patient data records and publishing cumulative data would allow for more accurate calculations in the future.

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