University of Pannonia

Doctoral School of Management Sciences and Business Administration

Koczor-Keul Melinda

Analysis of the death-related health care expenditures of the Hungarian elderly

Doctoral (PhD) dissertation – Repertory of Theses

Consultant: Dr. Molnár Tamás PhD

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Abstract

The end of life health care expenditures represent a topic of growing interest in academic circles, and in the recent years an increasing number of scientific works addressed the so called costs associated with death. Although the results are different, they agree on the fact that most of the health costs are accumulated in the last year or last months of life, regardless of the individual's age at the time of death. So the cost of dying represents a significant amount of the total health care costs during the life time.

Because of their size, knowing the patterns of these end-of-life health expenditures is essential when predicting future health costs. In case of the elderly, health costs are higher than in any other age group, as they are the ones who are usually the closest to death, so the higher costs associated with death are mainly connected to them. Therefore, we may think that demographic aging can have important consequences for the sustainability of future health systems.

These are the reasons that inspired me to analyze how the health care costs of elderly people develop at the end of life. In this area, the Hungarian scientific literature legs behind. Based on individual data, health expenditures incurred before death have not yet been investigated. For this reason, I consider my doctoral dissertation as a niche research that contributes to the better understanding of the impact of demographic aging in our country.

The data used for the research were filtered from the health insurance database managed by the National Health care Service Center. This database comprises the personal care data of every insured person. The records of care are provided by the health care providers with data contents prescribed by law. I had access to the data on the use of public-funded health care providers for the entire Hungarian population, so my database was well suited to answering my research questions. It was possible to study both temporal and spatial changes. Thanks to the universal coverage of the insurance system in Hungary and to the large number of cases, I was able to draw system-level conclusions.

From the database, I obtained health insurance claim information during the year prior to death for those individuals who died in fiscal year 2014 and were at least 65 years old.

In my research, I have come to the following conclusions:

- Health spending has shown a significant increase in the last seven months of life.
- When I investigated the gender differences, I found that men have significantly higher health care expenditures in the last seven month of their life.
- The death-related health expenditures of the elderly population decrease with age.
- People need more and more chronic care as they are getting older.
- The death-related health expenditures are disproportionately distributed across individuals, they are strongly concentrated in a small proportion of the population.
- Health care expenditures are explained by age and also by time to death, but the explanatory power of the remaining time until death is greater.

1. The actuality of the subject and the structure of the thesis

The usage of health care services is sometimes necessary during our lifetime, but towards the end of life is almost inevitable. The health services received at the end of life tend to be expensive and complex and affect not only the suffering individuals, but also their family members and the society as a whole.

Because of their size, knowing the behavior of these costs is important when anticipating the future development of health spending. Health care costs are higher for the elderly than for any other age group, since the elderly are usually the closest to death, so the higher costs associated with death will mainly occur in their case. Therefore, it is essential how the demographic aging phenomenon is taken into account in the forecasts.

It is not surprising that, when developing health policy, aging is often seen as the main driving force behind the growth of health spending. The observation that above age 40 the growth of per capita health spending and age are generally positively correlated, confirms this view. We may think that population aging can have important consequences for the sustainability of future health care systems.

Various studies which examined health care expenditure show that a disproportionate share of health care resources is being absorbed by incurable patients. The question may arise whether it is worth "wasting" these expensive resources for dying patients (especially if the patients are very old) or whether it is more useful to cure other patients or to spend that money for other socially desirable purposes, for example education or housing.

As the majority of deaths occur among the population aged 65 or over (for example, in Hungary in 2015, 75.6% of all deaths occurred in this age group), it is worth focusing on this age group with the abovementioned expenditure-cutting efforts. Although I disagree with this view, considering the issues raised by various studies, I think that it is necessary to examine in detail how health spending is developing at the end of life.

Recent trend in research, however, goes some way against the traditionally accepted narrative – which states that the growth of health spending is caused by aging - because several studies have come to the conclusion that health care expenditures show a steep growth only towards the end of life, suggesting that actually "death, or dying" is responsible for most elderly health care expenditure. Although aging is closely related to dying, when predicting the future health

costs, we have to distinguish between the two concepts. If aging is the cause of high health spending, increased life expectancy exerts higher cost pressures on the health care system, but if "dying" is the cause of these, then this cost pressure will be much less severe since most people usually experience this physiological process only once, regardless of how long they live.

However, in recent years there is a paradigm shift in the viewpoint of researchers. More and more people argue that the population aging will not have so serious consequences as previously assumed, because the most significant cost occurs due to death, that is, in the last year or last months of life, and not because of old age as a condition.

The new approach in literature is that health expenditures do not depend on the time elapsed since birth, but on the time remaining until death. In other words, the average health care cost increases as a function of age, just because the number of people who are closer to death increases with demographic aging. As life expectancy increases over time, the curve of health care costs as a function of age will become less and less steep, as in the future, 65-year-olds will not be in the same stage of their life-cycle as they were a few decades ago.

This topic has not yet been addressed by the Hungarian literature. No investigation exists based on individual-level data about the health expenditures incurred before death, so there are many open questions in this field. For this reason, I consider my work as a niche research that contributes to a better understanding of the impact of demographic aging in our country. In my Ph.D. dissertation I do not try to answer every question that can be asked. My aim is to examine, within the available database, how health expenditures have evolved in the elderly population as they approach their deaths. The findings do not show the extent to which health resources are wasted on terminally ill patients, but they contribute to a better understanding of the health care expenditures of the elderly in the months before their death.

Because of the above-mentioned reasons my research included the elderly individuals, i.e. people over the age of 65, who died during 2014, in total 95,850 persons. The purpose of my research is to study how the health care of elderly people develops at the end of life.

The data used for the research were filtered from the health insurance database managed by the National Health care Service Center. This database comprises the personal care data of every insured person. The records of care are provided by the health care providers with data contents prescribed by law. I had access to the data on the use of public-funded health care providers for the entire Hungarian population, so my database was well suited to answering my research

questions. It was possible to study both temporal and spatial changes. Thanks to the universal coverage of the insurance system in Hungary and to the large number of cases, I was able to draw system-level conclusions.

The centrally available supply data contain extremely valuable system-level information and are perfectly suitable to answer my research questions. It has become possible to study both temporal and spatial changes. In Hungary, the situation is particularly fortunate because, thanks to the universal coverage of the insurance system and the large number of cases, the conclusions drawn apply to the whole system.

My database contains the health care expenses for every insured Hungarian elderly (those aged 65 or over) who died during 2014, so my analysis is not based on a sample. The tests were performed on the entire Hungarian population with insurance, who fulfilled the above mentioned two conditions.

The health care expenditures included in the study cover 4 categories of benefits. They include: outpatient care, active inpatient care, chronic inpatient care, and prescription drugs. The analyzed expenditure is therefore limited to specialist care. In addition to the specialist care expenses, I also included medication data in the analysis. All the costs were in monthly breakdown and on individual level for the last 12 months prior to the death.

For the purpose of the study, I used the ANOVA analysis, independent-samples t-test, correlation calculation, regression analysis, Lorenz diagram, the Gini- and the Herfindahl coefficients. The tests were performed by using EXCEL software and PASW Statistics18 software.

The dissertation consists of five chapters.

In the first chapter, I analyzed in a European context the past tendencies of population aging in Hungary, the health status indicators of the population and the health expenditures, but also the demographic trends that will be expected in the future. I closed this chapter with the issue of sustainability of health care systems.

In the second chapter, I summarized the results of the studies in which the impact of demographic aging on health expenditures was explored. In this chapter, in addition to the demographic factors, I also highlighted the impact of major non-demographic factors influencing health expenditure. I have paid particular attention to those studies that have

investigated the death-related costs and the way health expenditures are shaped as a function of the time to death.

In the third chapter I present the database used for the research. This chapter describes the general characteristics of the population under investigation, the data sources, and the process of building the final database from the data I had access.

In the fourth chapter of the research I formulated my research questions and the related hypotheses. Subsequently, I used the statistical methods suitable for testing the hypotheses to examine the death-related health expenditures of the elderly population in Hungary. Based on the results of the analyses, I formulated my theses.

In the fifth chapter, the results of my research are confronted with the results of the most important international researches.

In the sixth chapter, I outline the possible research directions that could not be elaborated in this dissertation, but which I consider important to be performed in the future.

2. Description of the database

The data used for the research were filtered from the health insurance database managed by the National Health care Service Center. This database comprises the personal care data of every insured person. The records of care are reported by the health care providers with data contents prescribed by law. I had access to the data on the use of public-funded health care providers for the entire Hungarian population, so my database was well suited to answering my research questions. It was possible to study both temporal and spatial changes. Hungary has a single-payer system, with the central government playing a dominant role. Thanks to the universal coverage of the insurance system in Hungary and to the large number of cases, I was able to draw system-level conclusions.

The database of the National Health care Service Center contains records of health care services used by every insured person, and stores also personal data of people alive in and after 1995. Every month the health care providers with funding contracts with the Fund report their performance. The data serve as a basis for the funding of the services performed by the health care facilities. This is why, in Hungary, the situation is particularly fortunate because, thanks to the insurance system, the database is complete. This database with an exceptionally high data content uniquely contains relevant health data for more than 10 million persons in a relatively stable data capture structure.

2.1 Determination of the population included in the study

My database contains health care expenses for every insured Hungarian elderly (those aged 65 or over) who died during 2014, so my analysis is not based on a sample. The tests were performed on the entire Hungarian population with insurance, who fulfilled the above mentioned two conditions. Thus, I had access to a database which contained system-level information.

The coverage of public health insurance in Hungary was 95,2% in 2014, so the population included in the analysis can be considered as representative. The total cohort of the survey included 95.850 persons.

For each individual the gender, year of birth, postal code of residence, date of death have been filtered. In the case when the patient died in a health care institution, the postal code of the institution was included in the database.

2.2 The privacy rights of the research subjects

The privacy rights of research subjects should be protected. This is not just a legal but also a moral obligation. One way of protection is that the data are anonymized before being handed over to the researchers. For the purpose of anonymizing the data, the TAJ identifiers (social insurance identification number) were encrypted to a pseudo-TAJ identifier that is equally suitable for personal identification, so that data of the same individual can be linked. A person has the same pseudo-TAJ throughout his life so that his entire path of illness can be traced. The purpose of anonymization is to transform personal data in a way that they can no longer be linked to natural persons.

2.3 Determining the health expenditures included in the study

The health care expenditures included in the study cover 4 categories of benefits. They include: outpatient care, active inpatient care, chronic inpatient care, and prescription drugs. The analyzed expenditures are therefore limited to specialist care. In addition to the specialist care expenses, I also included medication data in the analysis.

The data of primary care (general practitioner, mother, child and youth protection, mobile specialist services, dental care, rescue, patient and dead transportation) are not included in the database of National Health care Service Center, so I did not have access to this information. My database also lacks the home care and hospice care expenses.

2.4 The database used to verify the hypotheses H1-H5

In the first round, were selected the individuals over the age of 65 who died in 2014. They represent in total 95,850 persons. In the case each individual, I needed in a monthly breakdown the costs of outpatient care, active inpatient care, chronic inpatient care and the publicly-supported value of drug use for the 12 months prior to their death. To do this, however, it was

necessary to count down 30-day periods from the date of death. Subsequently, I allocated the expenses to every month in question.

Number of points for outpatient care

Thus, the table of people over 65 years of age who died in 2014 was produced, and then for each of the 95,850 TAJ included in this database the records of outpatient cases were added, by calculating in which month before death (calculated with 30-day months) did the given event occurred.

Subsequently, for each TAJ-identifier, the points of outpatient services were aggregated for each month. For institutions providing outpatient care (including lab diagnostics, CT and MRI), financing is based on performance principles. All interventions, medical procedures have a funding point value and a code. The points reflect the cost ratios between each intervention, these are the basis for funding.

So I got to a table containing the TAJ-identifier of each individual and the points of outpatient care interventions from the first until the 12^{th} month before his death.

The weights of active inpatient care

The active inpatient care provision is funded according to the type and severity of the inpatient case, based on the HBCS (Homogeneous Disease Groups) classification system. This financing method means that the inpatient facility providing the active care receives funding on the bases of the weight numbers assigned to the HBCS. HBCS is a case classification system that classifies inpatient cases that have the same or similar intensity of intellectual and financial cost in homogeneous groups, taking into account their medical professional content. Since the performance value is considered to be the same in a given HBCS, a single fee will be assigned regardless of the number of medical interventions performed in the therapy, so the amount to be financed is determined before the service is performed. A cost-weighting number (number of points), was defined for each group of diseases, and the hospitals' monthly output in terms of HBCSs is financed according to the total number of HBCS points multiplied by the monetary value of 1 point, the so-called national base rate. The national base rate is set in advance and it applies to all hospitals equally.

For the active inpatient care, each of the nursing cases is encoded with a unique key. The

database contains the patient's pseudo-TAJ identifier, date of admission, date of discharge, and HBCS weight for each nursing case. As a difference between the date of entry and departure, the number of nursing days for each case was determined. The next step was to count back from the date of death twelve 30-day months periods and for each of these periods I had to assign the weight of the active inpatient care given in that month. Since a nursing case could last for more than 30 days, it was necessary to allocate the HBCS weight of the entire case pro rata temporis.

In the first step, I calculated to which month before the death belonged the date of the admission and the date of departure. In case the date of admission and the date of discharge was in the same month before the death, the total weight of the care episode was assigned to this month. If, however, this was not the case, i.e. the admission of the patient was in one month before the death, while the departure occurred in another month before the death, it was necessary to determine the number of nursing days to be taken into account for the given month prior to the death, and the aggregated weight of the HBCS. The aggregate weight was obtained as a product of the number of nursing days per month and the HBCS weight per day.

As a final step, it was necessary to summarize the supply cases by TAJ, as there could be several cases of supply to the same TAJ (either because the patient was admitted multiple times during the given 30-day period, or because the hospital case was divided between several departmental cases).

In the case of individuals who did not receive active inpatient care during a month before their death, I set the weight number to zero.

The number of nursing days of chronic inpatient care

In the case of chronic inpatient care, the financing is based on a daily fee for every nursing day. The daily base fee is corrected by multiplying with different weights according to the specialized tasks.

Therefore, for each of the 12 months prior to the death of the patient, the number of chronic inpatient days had to be determined separately for each TAJ.

Similarly to the active inpatient care, the database contains the patient's pseudo-TAJ identifier, date of admission, date of discharge. As a difference between the date of entry and the date of departure, the number of nursing days for each case was determined. The next step was to count back from the date of death twelve 30-day months periods and for each of these periods I had

to assign the number of chronic inpatient days for care given in that month. In contrast to the active inpatient care, the long-term care is even more typical for chronic cases. Since a nursing case could last for more than 30 days, it was necessary to allocate the nursing days of the entire case pro rata temporis.

In the first step, I calculated to which month before the death belonged the date of the admission and the date of departure. In case the date of admission and the date of discharge was in the same month before the death, the total number of chronic nursing days was assigned to this month. If, however, this was not the case, i.e. the admission of the patient was in one month before the death, while the departure occurred in another month before the death, it was necessary to determine the number of nursing days to be taken into account for the given month prior to the death. In order to determine the funding basis for chronic care, the number of days per month needed to be multiplied by the weights of the specialized tasks.

As a final step, it was necessary to summarize the supply cases by TAJ, as there could be several cases of supply to the same TAJ (either because the patient was admitted multiple times during the given 30-day period or because the hospital case was divided between several departmental cases). In the case of individuals who did not receive chronic inpatient care during a month before their death, I set the number of days to zero.

Publicly-financed amount of drug prescriptions

I supplemented the database with the social security benefit of medicines purchased under outpatient care.

For every prescription were available the full price and the amount of price supported by the National Health Insurance Fund (Hungarian acronym: OEP) for every month before death. The only task here was to aggregate the values by TAJ, since the same patient could have obtained multiple prescriptions within the same 30-day period.

Aggregated expenditures

In order to aggregate for every individual the points of outpatient care, the weights of active inpatient care and the weighted nursing days of chronic inpatient care, it was necessary to transform them into forints.

The performance-based financing of active and chronic inpatient specialist care is based on a predetermined, nationwide standard fee. In the case of active inpatient care services, as the performance value is the same within a HBCS, the therapist will receive a single fee for the full therapeutic event, irrespective of the number of medical interventions carried out under the therapy, so the financed value is determined before the service is performed. In the case of chronic inpatient care financing is provided with a daily remuneration.

The funding fee for individual cases of therapy is determined by the OEP as a product of the HBCS Weight / Chronic Care Days and the pre-announced nationwide standard fee. This means that each health care provider receives the same fee for the same case.

For the purpose of expressing the performances in forints I have used the values valid since January 2017.

After that, I produced a table in which I summarized for each individual and for each month before death the value of outpatient care, the value of active inpatient care, the value of chronic inpatient care and the value of publicly-financed price for medicines. Thus, the most important expenditures of specialized care were aggregated.

2.5 The database used for verifying H6 hypothesis

For this purpose, in the way described above I have collected the January 2014 expenditures of those over the age of 65 who died in 2014. From this database, I excluded those who died in January 2014 because to them I could not assign a full month expense for January. In the final database, were included 87,331 individuals out of the total 95,850 decedents, 8,519 people died in January. After that, I defined the remaining time to death for each individual by calculating the number of days elapsed between 31.01.2014 and the date of death.

3. Research questions, hypotheses

During my research I was looking for the answers to the following questions:

- Is there any change in health care spending for the elderly, as individuals are approaching death?
- Can gender differences be observed in health care expenditure at the end of life for age groups over 65?
- Do health expenditure at the end of life show a difference between the age groups of the elderly population?
- Does the use of active and chronic inpatient care change as people are getting older?
- How concentrated are the death-related health care costs in case of the elderly population?
- To what extent does the age and the time to death explain the health expenditures?

To answer these questions I have set the following hypotheses:

H1: The health care expenditures of elderly people show a significant increase in the last few months of life.

H2: For women, the death-related health expenditure of the elderly are higher.

H3: Proximity to death for the oldest people does not increase health spending as much as for younger elderly, so with the progress of age the near-death medical expenses are decreasing.

H4: The composition of death-related health care expenditures for elderly is dependent on age. As the age progresses, chronic inpatient care costs represent an increasing proportion of near-death expenditure while the proportion of active inpatient care expenditure is declining.

H5: The death-related health care expenditure of the elderly is heavily concentrated in a small proportion of the population.

H6: Health expenditures are explained not by age, but by the time to death.

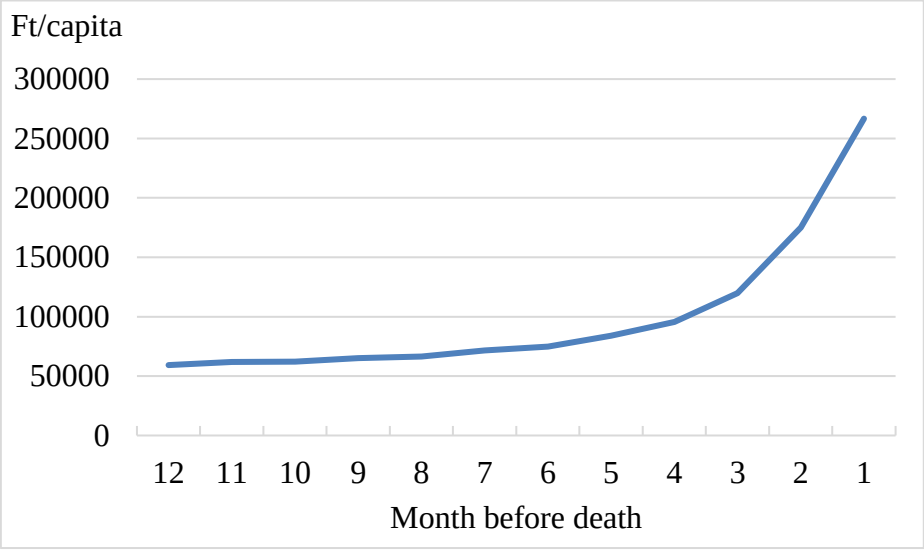
4. Examination of the hypotheses

My first hypothesis was that health expenditures of the elderly are concentrated in the last few months of life, that is, as an individual approaches death, he or she increasingly uses health care services, so a significant increase can be observed in the health expenditures. The goal was to determine from which month before the death the spending starts to increase, so it was necessary to perform comparisons in pairs.

To test my hypothesis, I used the one-way ANOVA analysis. For the purpose of the analyses I separated the total value of individual expenditures for the 95,850 decedents by the time remaining to death. The time remaining until death varies between 1 and 12, and shows the monthly cost of health care received by every individual each month during the 12 months prior to his death (30 days months). So I had 12 samples, each containing 95,850 records.

The result shows that the *F* ratio is significant, so it can be concluded that a difference between means exists, the different time periods until death have different effects on health expenditure. To determine which specific means are different, the post-hoc analyses was performed. The conclusion was, that the 8th month is the period after which a significant increase can be justified in the averages of successive months (Fig. 1). There is no significant difference between the 8th and 9th months.

Figure 1: The average per capita health care expenditure in the last 12 months prior to the death



Source: own calculation

In the first month, expenditures rose by more than 1.5 times compared to the 2nd month before death. The total cost of care for the 95,850 decedents in the 30 days prior to their death totaled HUF 25.6 bn, which is 4.72 times higher than in the 12th month before their death, when the amount was HUF 5.7 bn.

When I examined men and women separately by using the one-way ANOVA analysis, this trend remained, only the significant differences between the averages have changed. For women, the monthly average expenditures are lower. In the last month of life, men's average spending is 1.3 times higher than the women's average value over the same period.

It can therefore be concluded that per capita health expenditures are the highest in the first month before the death, and that growth can be justified starting with the 7th month. In the first month before death, per capita average spending was more than 4 times higher than in the 8th month before death.

Expenditures for active inpatient specialist care show a similar tendency as aggregate expenditures. In the case of these expenditures, the seventh is the first month with significantly higher expenditures, so it is possible to justify differences between the averages of successive months after the 8th month. As active inpatient care represents the largest portion of the total spending, it is not surprising that aggregate and active inpatient expenditures have changed in a similar way. As compared to the total average health expenditure per person in the last 30 days, active inpatient care represents 83.5%, so this type of care represents the highest cost burden.

The total active inpatient care expenditure of the 95,850 decedents in the last 30 days prior to their death was HUF 21.3 bn, almost 9 times higher than the value for the 12th month before death, when the sum was only HUF 2.4 bn.

When I examined men and women separately, this trend remained, only the significant differences between the averages changed. For women, the average costs are lower.

The variance analysis was also performed on the value of the weighted days of chronic inpatient care and the results showed that the expenditures did not change significantly before the 8th month. The result is interesting, as in the first month before the death there is a significant decrease in average per capita expenditures for chronic inpatient care: the decrease was 2,535 HUF / person compared to the second month before death.

This trend remains the same when examining women and men separately. The difference between the two sexes is that men's averages are well below the averages of women.

I also performed variance analysis on the forint value of outpatient care points and the results show that within the 12 months before death, a period with significantly higher expenditure can be distinguished. Thus, in the case of these expenditures we can also determine a dividing time-line within one year before the death, when we can see a significant increase in expenditures compared to previous periods.

It can be concluded that when approaching death the significant increase in the average outpatient expenditures is first verifiable between 6th and 7 th months. It is true that the growth between the 5th and 6th months did not prove to be statistically significant, but thereafter the increase can be justified between every month-pairs.

This result is true for both men and women. The difference between the two sexes is that men's averages are well above average for women's. In case of men, as in the case of the whole population, growth is not significant between the 5th and 6th months, while in case of women there is no interruption in the significant increase of the average costs of consecutive months.

The variance analysis was also performed on the publicly-supported forint value of drug consumption. In this case the results were no longer as clear as in case of the other types of services. Pharmaceutical expenditures also show an upward trend as the time of death approaches, though there is no difference between the averages of consecutive months until the 4th month. There is a significant increase between months 3 and 4, and so is between months 2 and 3.

An interesting result is that there is a significant decrease in the first month before the death compared to the previous month's average. In my opinion, there are two reasons for this: one is that many people in the last month of life have been hospitalized, and the other is that the intensity of care is declining, the provided services are concentrated only on trying to alleviate the pain of the patients. In the case of pharmaceuticals, I also performed the ANOVA analyzes for men and women separately. In the last 30 days before death, the decline in expenditure is observed for both sexes.

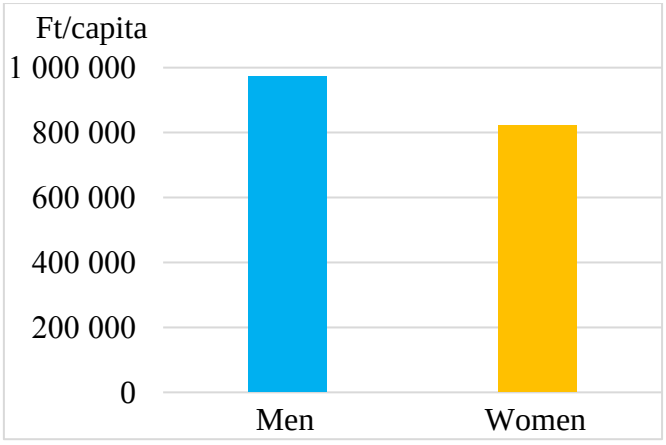
Based on these results I formulate my first thesis:

T1: Health care expenditures for the elderly show a significant increase in the last seven months of life compared to the previous months, both for women and men. Within all spending, active inpatient care expenditure shows the same trend while the forint value of the weighted days of chronic inpatient care records no significant change before the 9th month. In case of the outpatient care expenditure, the increase can be demonstrated first between months 6 and 7, although the growth between the 5th and 6th months did not prove to be statistically significant. The publicly-funded drug consumption shows a significant increase from the 4th month before death, but significantly decreased in the last month of life.

Because, when approaching the date of death, the seventh is the earliest month, for which the health care expenditures are significantly higher, I define the death-related health expenditures as the cumulative spending of the first 7 months before death.

The second research question is related to the gender differences in the death-related health care expenditures. My assumption is that women pay more attention to their health and are more likely to be investigated, so in their case, health spending is higher at the end of life than the costs for men. For this purpose I divided the population by gender into two subgroups (41,671 men and 54,179 women). I used the independent samples t-test to compare the means of death-related expenditures for men and women in order to determine whether there is statistical evidence that the means are significantly different. The results of the test indicated that if we look at the expenditures separately for men and women, there is a significantly lower average spending for women in the last seven months of life.

Figure 2: The gender differences between average per capita health care expenditure in the last 7 months of life



Source: own calculation

The significant difference between the averages of the two groups is 136,048 HUF / person.

If we look at spending on active inpatient care, there is a significantly lower average spending for women. The justified difference between women and men in the death-related active inpatient care provision is 125,772 HUF / person, the average for women is much lower than that of men.

There is also a significant difference between women and men in chronic inpatient care. It is interesting, however, that men's expenditures are lower in this case. With a significant difference of 17,509 HUF / person, the average chronic inpatient care expenditure of women is higher.

There is also a significant gender difference in the outpatient care expenditures, but in this case the difference between the sexes is much lower than for inpatient care. The average cost of men is significantly higher than that of women, the significant difference for this type of care is only 8,991 HUF / person.

There is also a difference in gender-specific publicly-supported value of drug use expenditure. In the case of publicly funded drug use, the average for males is higher among women. Here the significant difference in the costs is 11,989 HUF / person.

Based on the above analyses, I formulate my second thesis:

T2: The death-related health expenditures of the elderly are higher for men than for women, not only in the case of aggregate expenditure, but also for the active inpatient care, outpatient care and the publicly-funded expenditure of drug use, whereas for the chronic inpatient care expenditures values of women in higher.

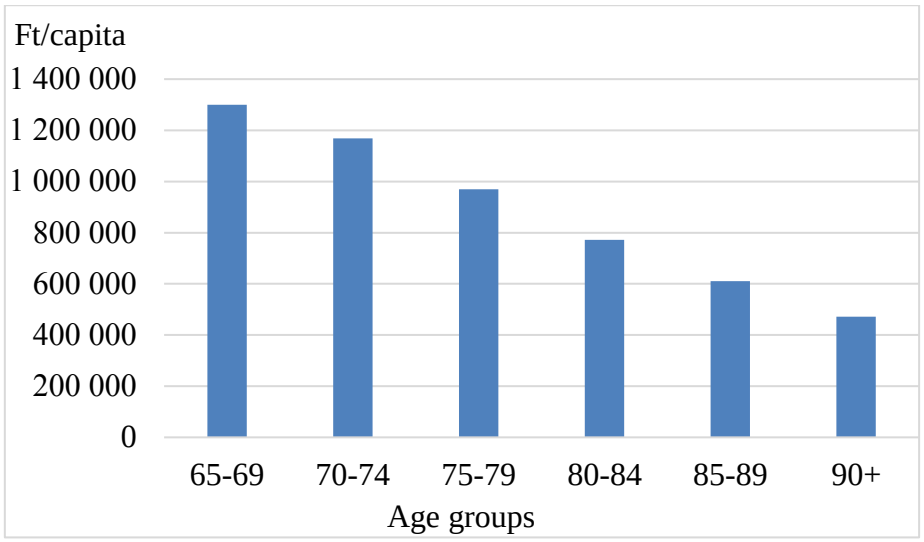
In my third hypothesis, I was looking to find the answer to the question how health expenditures before death are developing for different age groups. I assumed that with age the spending will shrink, so dying at a very old age is cheaper than at a younger age.

For the purpose of the analysis, the total population was divided into 6 age groups, according to their age in the year of death (2014). I compared the averages of these six age groups with variance analysis.

The result of the analysis shows that in the last seven months of life the health care expenditure records a significant decline between the age groups, the most costly patients are those who die

younger. The pattern of decreasing expenditures with age is persisting throughout the last seven months of life in case of both sexes.

Figure 3: The average per capita health care expenditure in the last 7 months of life for different age groups



Source: own calculation

To measure the strength of the relationship between age and the death-related health care expenditures I performed correlation calculations. In this case, I did not disaggregate individuals into age groups, but I included every person with age at death. The average age of the decedents was 80.24 years.

The correlation coefficient is -0.174 between age and the health expenditures of the last seven months before death, which means that there is a weak negative relationship between the two variables, and this with a 99.9% probability is not a random consequence. The correlation is acceptable with at least 1% significance level.

Based on the results of the variance analysis and the correlation calculation I formulate my third thesis:

T3: As age is increasing, the death-related health care costs of elderly people are decreasing.

To test the fourth hypothesis, I examined separately for each age group whether there is any difference between active and chronic inpatient specialist care expenditures. I assumed that the composition of the death-related health care expenditures of the elderly depends on age. As the

age progresses, chronic inpatient care costs represent an increasing proportion of the total near-death expenditure while the proportion of active inpatient care expenditure is declining.

The *F*-test of the variance analysis is significant for both types of care, so there is a difference in the expenditures between the age groups. I have analyzed which age groups differ verifiably from each other by performing the post-hoc tests.

In the last seven months of life, active inpatient care expenditures show a significant decrease between the age groups, so the cost of inpatient active care decreases with age. In the case of chronic inpatient care expenditures the conclusion is not so clear, spending first progresses with age, and begins to fall just over the age of 85. The growth between the first four age groups (65-69, 70-74, 75-79, 80-85) is significant. There is no significant difference between averages among the 4th and 5th age groups (85-89 years, and 90+), but a decrease can be observed in the averages here. For the oldest age group (90+), expenditure is significantly lower than in the case of 85-89 year olds. So, the death-related inpatient costs of chronic care for the elderly grow until the age group 80-85 and then start to decrease.

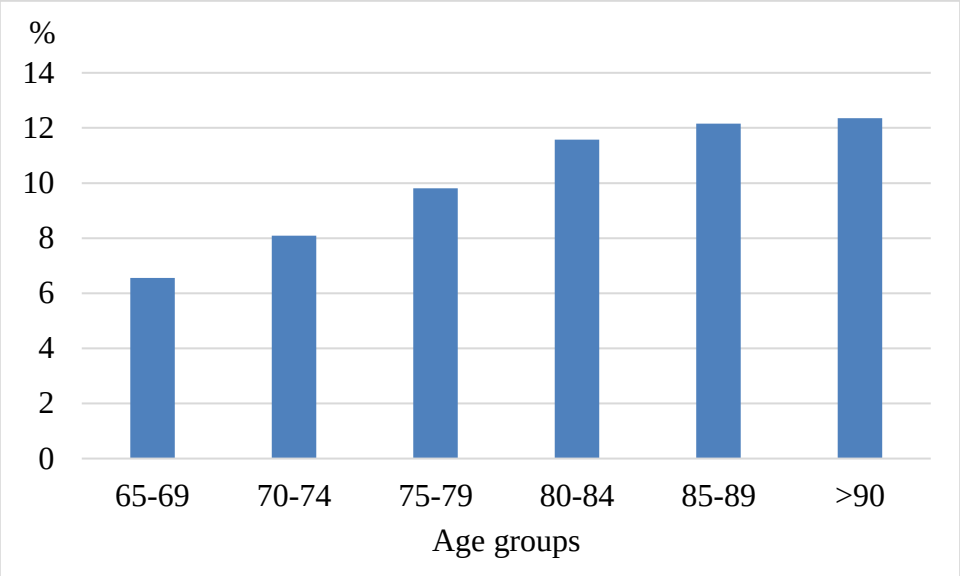
Thus, in the case of the younger age groups, the share of active inpatient care in the total death-related costs, are higher while this rate is lower for the older age groups. At the same time, as the age progresses, the proportion of chronic inpatient care expenditure in the total death-related expenditures increases among the age groups.

For the purpose of the analysis, I computed for every individual the ratio *chronic inpatient expenditures / (active + chronic inpatient expenditures)* and I have tested with variance analysis if there were any differences in these values between the age groups. There were several people who did not use during this period either active or chronic inpatient care services, so they were omitted from the analysis. As a result, I ran the test for a total of 62,464 people.

There is a significant difference between the averages of the indicator among the age groups, as the *F*-test is significant. To see among which of the age groups is there a verifiable difference I used the post-hoc tests.

The results show that the share of chronic inpatient care expenditure in the amount of chronic and active inpatient expenditure increases with age, although over 85 years this growth is statistically no longer significant. This means that people in the last seven months of their lives, the older they were, the more they used the services of chronic inpatient care (Figure 4.).

Figure 1: The average *chronic inpatient expenditures / (active + chronic inpatient expenditures)* ratio for different age groups



Source: own calculation

However, before I drew conclusions, I analyzed, whether there is any difference in the average of the ratio among the sexes. The population tested included 27,586 men and 34,878 women. I could demonstrate significant increases both for females and males only between the first four age groups, there was no significant change between the 80-84 and 85-89, respectively between the 85-89 and 90+ age groups.

My fourth hypothesis was partially justified, so I formulate my fourth thesis:

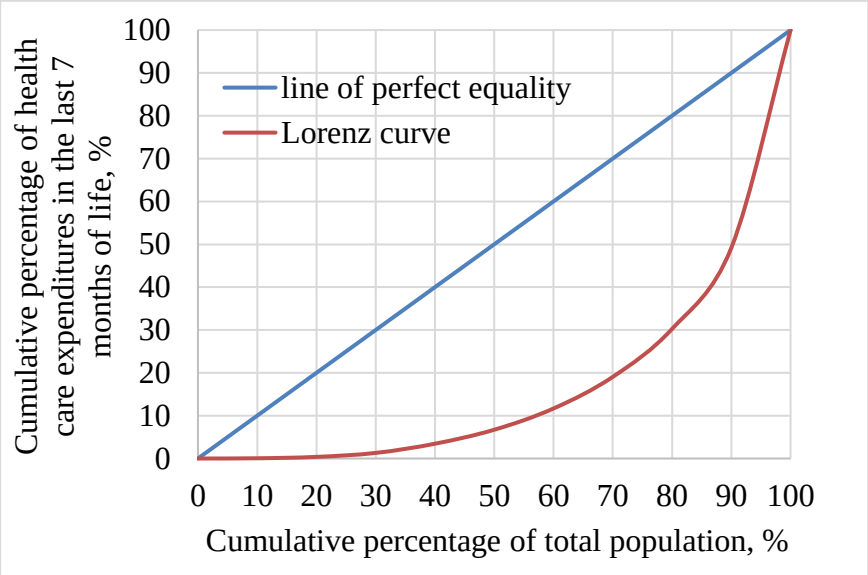
T4: The composition of elderly death-related health care expenditures is dependent on age. As the age progresses, between 65 and 84 years the proportion of chronic inpatient care costs in active and chronic inpatient expenditures increases significantly, while over the age of 85 the growth is no longer significant.

My fifth hypothesis was, that death-related health care expenditures of the elderly are heavily concentrated in a small proportion of the population, meaning that a significant part of the total value of the spending is concentrated on a small number of people.

In order to justify my hypothesis, the population was ranked in ascending order according to the near-death health care costs, and then I drew the Lorenz curve of death-related health expenditures (Figure 5.), which shows a significant deviation from the line of perfect equality.

More than 50% of expenditures are related to only 10% of the population. The first 10% of the population is responsible for only 0.06% of total expenditure.

Figure 5: The Lorenz-curve for the death-related health expenditures of the elderly



Source: own calculation

Using the Gini coefficient, I computed the size of the area enclosed by the square diagonal and the Lorenz curve. The closer the Gini concentration coefficient is to the 1, the higher the concentration. In the analysis, the calculated value was 64.7%, which indicates a strong concentration, i.e. in the 7 months prior to death the health expenditures of the deceased were concentrated in a small number of patients. The Hirschman-Herfindahl concentration index is 0.316.

More than 12.6% of the expenditure is related only 1% of the population. 5% of the population is responsible for more than 35% of total expenditure. By comparing the per capita averages of each group, it can be seen that average expenditure of the top 10% of the population is almost nine hundred times higher than the spending for the bottom 10%.

I also examined whether there is a difference in concentration between different age groups. It is apparent from the development of Lorenz curves that the concentration of expenditures is not significantly dependent on age, and this finding is also supported by the Gini coefficients and Hirschman-Herfindahl concentration indexes.

When examining how the concentration of expenditure is influenced by gender, the results show that there is no difference between women and men in the concentration of health spending for last seven months before death. The Lorenz curves of the two sexes are nearly coincided, and

the Gini coefficients and the Hirschman-Herfindahl concentration indexes shows only a small difference.

When I looked at concentrations by type of care, chronic expenditures show the highest concentration and the outpatient spending shows the lowest. The values of the Gini coefficient and the Hirschman-Herfindahl concentrations index also supports this conclusion.

My hypothesis was justified, so I formulate my fifth thesis:

T5: Death-related health care expenditures for the elderly are heavily concentrated in a small proportion of the population, so the spending is very unequally distributed. This concentration effect prevails most in the case of chronic inpatient care expenditure, while the lowest concentration is shown by outpatient expenditure. Concentration is not depending on age or gender.

In the last hypothesis I assumed, that health expenditures are explained not by age, but by the time to death. The purpose of this analysis was to identify the importance of age and time to death in explaining health expenditures. To test this hypothesis I used linear regression calculation. As the dependent variable of the model, I introduced the January (2014) expenditure, and the explanatory variables were the age and the time to death (in days).

Of the total population, 8,519 people died in January 2014. Since they died during the month, to them I could not assign a full month expense for January, so these people were not included in the database. The analysis was performed based on data of 87,331 persons.

The square of the multiple correlation coefficient is 0.03, the model's explanatory power is low. The *F*-test has a significance level of 0.000 <0.05, so the model has some explanatory power, even if it is small.

The *t*-test of the coefficients has a significance level of 0.000 <0.05. Since both independent variables (age and time remaining until death) as well as the constant are significant, all of them can be included in the model:

Health expenditure = 533,436.286 – 559.768 * remaining time to death – 4297.489 * age

The time to death variable has a greater explanatory power than age, since the standardized coefficient (beta) of this variable is higher (-0.146 against the -0.094 value for age).

The partial correlation coefficients were as follows:

Age: 0.008648

Time to death: 0.020592

$R^2 = 0.02924$

Partial determination coefficients:

Age: 0.296

Time to death: 0.704

Based on these results, it can be concluded that health expenditures are explained in 29.6% by age and in 70.4% by the time left to death.

Based on the results of my examinations I formulate my sixth thesis:

T6: Health expenditures are explained both by age and by the time to death, but the explanatory power of the remaining time to death is greater.

5. Summary of theses

In order to facilitate transparency, I summarize the hypotheses and the theses formulated based on the analyses:

HYPOTHESIS	THESIS
H1: The health care expenditures of elderly people show a significant increase in the last few months of life.	**T1: Health care expenditures for the elderly show a significant increase in the last seven months of life compared to the previous months, both for women and men. Within all spending, active inpatient care expenditure shows the same trend while the forint value of the weighted days of chronic inpatient care records no significant change before the 9th month. In case of the outpatient care expenditure, the increase can be demonstrated first between months 6 and 7, although the growth between the 5th and 6th months did not prove to be statistically significant. The publicly-funded drug consumption shows a significant increase from the 4th month before death, but significantly decreased in the last month of life.**
H2: For women, the death-related health expenditure of the elderly are higher.	**T2: The death-related health expenditures of the elderly are higher for men than for women, not only in the case of aggregate expenditure, but also for the active inpatient care, outpatient care and the publicly-funded expenditure of drug use, whereas for the chronic inpatient care expenditures values of women in higher.**
HYPOTHESIS	**THESIS**

H3: Proximity to death for the oldest people does not increase health spending as much as for younger elderly, so with the progress of age the near-death medical expenses are decreasing.	**T3: As age is increasing, the death-related health care costs of elderly people are decreasing.**
H4: The composition of death-related health care expenditures for elderly is dependent on age. As the age progresses, chronic inpatient care costs represent an increasing proportion of near-death expenditure while the proportion of active inpatient care expenditure is declining.	**T4: The composition of elderly death-related health care expenditures is dependent on age. As the age progresses, between 65 and 84 years the proportion of chronic inpatient care costs in active and chronic inpatient expenditures increases significantly, while over the age of 85 the growth is no longer significant.**
H5: The death-related health care expenditure of the elderly is heavily concentrated in a small proportion of the population.	**T5: Death-related health care expenditures for the elderly are heavily concentrated in a small proportion of the population, so the spending is very unequally distributed. This concentration effect prevails most in the case of chronic inpatient care expenditure, while the lowest concentration is shown by outpatient expenditure. Concentration is not depending on age or gender.**
H6: Health expenditures are explained not by age, but by the time to death.	**T6: Health expenditures are explained both by age and by the time to death, but the explanatory power of the remaining time to death is greater.**

At the beginning of my dissertation, I raised the dilemma of whether there is a potential cost-saving potential that can be perceived at the macro level if that government reduces funds spent on cure for those over 65 who are at the end of their lives. This is indeed an important matter of concern, so for the purpose of clarifying this question I compared the end-of-life health expenditure of people over the age of 65 with in-kind benefits financed by the OEP for the whole population.

If we assume that the average cost per capita in the last 7 months of life remains at the level of the 8th month, so there is no steep rise in spending nearing death, then the potential savings are HUF 40,418 mln.

My conclusion is that by reducing the amount spent on aggressive life-saving interventions in the case of dying elderly patients, it is possible to save up to 3.1% of the total in kind health care expenditures of the OEP, so it is not possible to achieve a substantial reduction in health expenditure at macroeconomic level.

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