A Crown Witness, or Several Conclusions Based on the Mathematical Analysis of the Statistics Published by WHO

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Since 14 March, I have been collecting data from the WHO server: "Coronavirus disease (COVID-2019) situation reports"[1]. On the occasion of the publication of the 100th report, I decided to share my conclusions with you. I have been collecting the data with a sense of humour, according to the principle promoted in the "Doctor House" movie: "**Everybody lies, but we are able to draw some conclusions, anyway**".

In order to show the diversity of the course of the pandemic and possible scenarios for our country, I have been collecting the data from **South Korea, Poland, Italy, Great Britain, France, Germany, Spain**, **and the USA**. Obviously, the situations of those countries may be different from one another, because the responses of the governments, health services, and local people were different and shall be different in future. I have not used the data from China because I doubt whether they are true. Instead, I chose South Korea to be an example of a country in which coronavirus appeared earlier than in Europe and in the USA.

From the reports, I only took the data collected in the form of charts with the following columns:

Reporting Country / Territory Area	Total confirmed cases	New confirmed cases	Total deaths	New deaths

The below brief text consist of three parts and a summary.

In the first part (entitled the *Outbreak of the Pandemic*), I described the dynamics of the development of the pandemic. Six diagrams illustrate how the perception of the coronavirus changed within a month and a half. There is no doubt that this is a warning showing **how, within a very short time, a pandemic may explode in the area where there was no pandemic or the pandemic was suppressed**. Comparing to the epidemic of HIV, we do not have much time for science and education – two basic factors that hinder the spread of viruses.

Sometimes, in the data published by WHO there were accidental mistakes which I did not correct. In the second part, I found and tried to correct the **systematic error resulting from the incorrect estimation of the number of infected people**. I also calculated the results per 1 million of citizens. After the correction, in Poland there is 1 infected person per ca. 600 inhabitants, in Germany – per 130 inhabitants, and in Spain, Great Britain and France – 1 person per 20. In the USA the result is 1 person per 60. **Thus, the Poles, just like the Germans, have enough time not only to improve the system of medical support, but also to implement proper systems of education in schools and universities.**

Similarly to most people who receive the information given by the media, I have been trying to answer the question: what is next? After reading this brief article, you will certainly see that, so far, it is impossible to answer it. However, we already know that the results of the pandemic may be tragic.

In the third part (*Dangerous Image of Pandemic*) I presented the percentages of deaths resulting from the coronavirus as compared to the expected deaths resulting from other causes. Within the last 10 days in Poland, the percentage is about 1-2%, in Germany – from 5 to 10%. **However, there are countries in which one in five deaths is considered to be related to the coronavirus.** And during the peak of the epidemic there were twice as many deaths there.

[1] From the website: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports

1 *Outbreak of the Pandemic of COVID-19*

The below 6 charts show the number of people infected with the coronavirus from 23 April to 16 April. For each chart, the length of time is two weeks – as long as the recommended time of the quarantine. A person who started the quarantine in one period of time, after two weeks returned to a different world. Today, in most of the selected countries, the dynamics of the development of the pandemic is still high, but it is not as high as at the beginning.

The scales of particular charts specify the first individual cases of infected people, the first hundreds/thousands/ tens and hundreds thousands cases. The numbers reflect the dynamics of the spread of the pandemics.

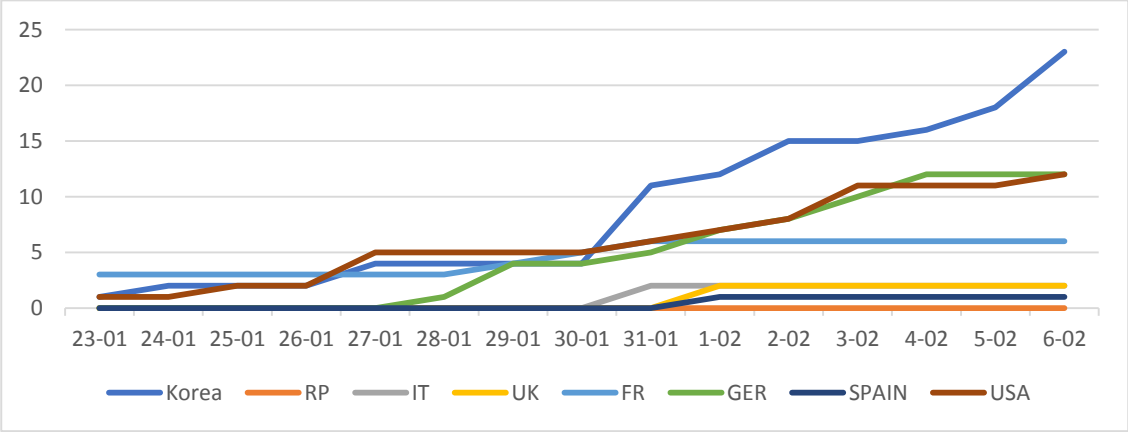

Chart 1.1. The first individual cases of infected people from 23 January to 6 February.

In South Korea, the number of the sick is close to 25. Also, more than 10 first infections are reported in Germany and in the USA.

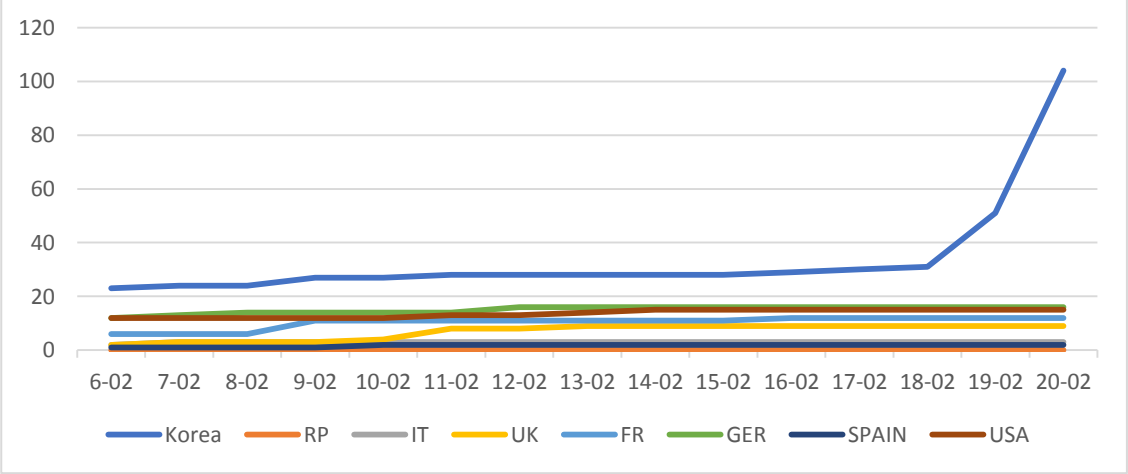

Chart 1. 2. The first hundred of cases in the period from 6 to 20 February.

Although, previously, the number of inflections in the USA and in Germany was comparable to the number in Korea, now the development of the epidemic in Korea is much more dynamic.

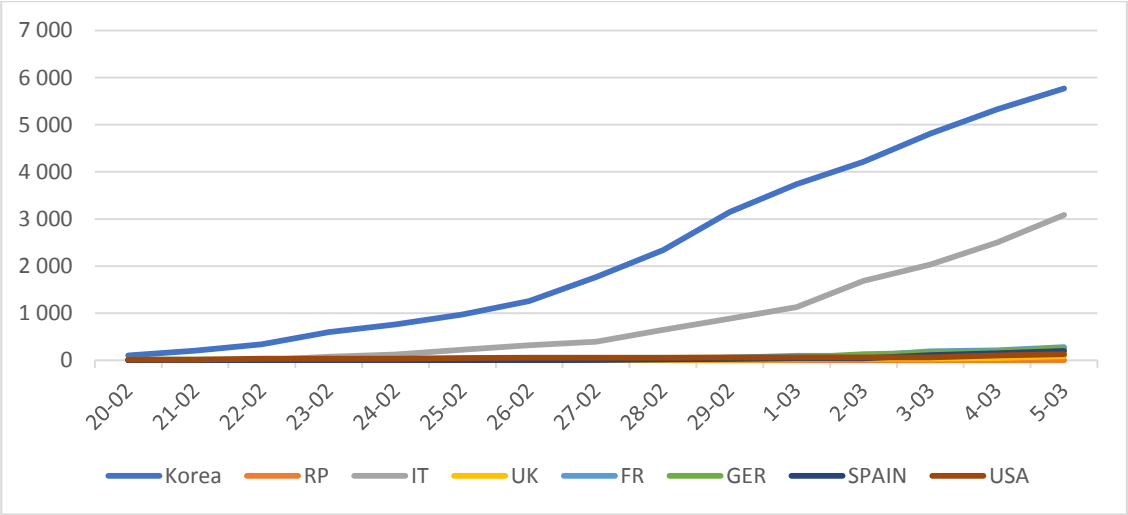

Chart 1.3. The first thousands of cases in the period from 20 February to 5 March.

These results certainly surprised many observers. The research carried out in Korea revealed thousands of the sick, who probably contracted the virus in the previous period, and were now identified due to the actions of the Korean medical service. Scientists were also surprised by the fact that the number of identified sick people significantly increased in Italy, and not in Germany or the USA. Perhaps the Italian medical service did not notice the threat within the past two weeks.

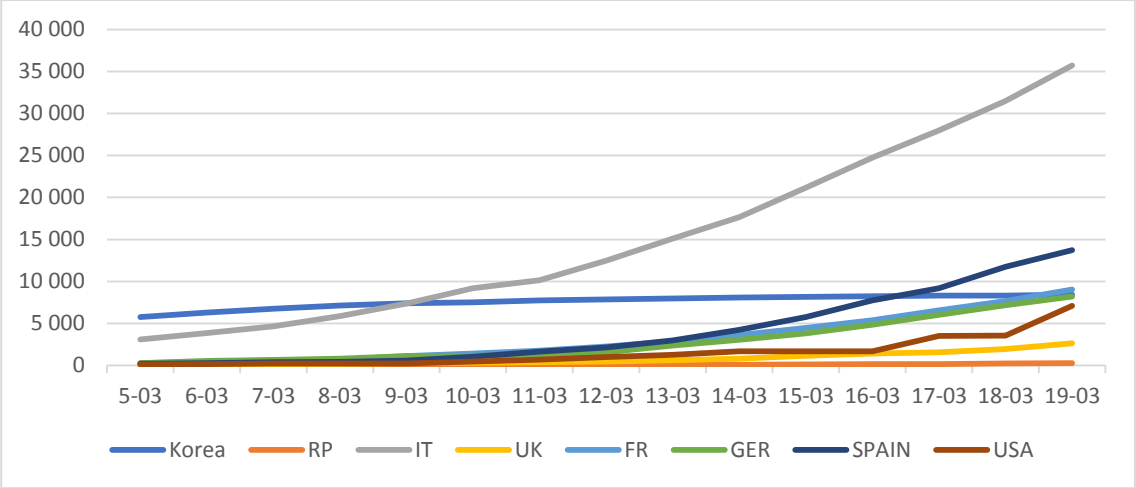

Chart 1.4. The first tens thousands of cases in the period from 5 to 19 March.

As a result of the intensive work of the Italian medical service, tens thousands of people infected with the coronavirus were identified. The number of the sick in Spain dangerously increased. The results obtained by the Korean society and its doctors were encouraging. The number of infected people stopped increasing so fast, which made everyone hope that the development of the epidemic can be stopped.

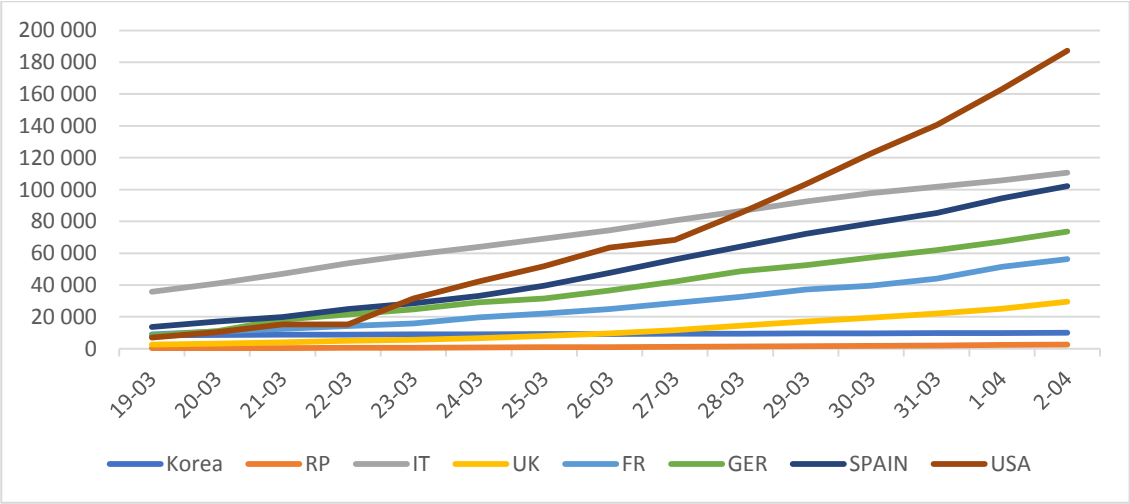

Chart 1.5. The first hundreds thousands of cases in the period from 19 March to 2 April.

Within two weeks, doctors from the USA found almost 200 thousand sick. The pandemic in the USA occurred a month later than in Korea, but, because of the size of the USA, the number of infected people is very high and it has to be assumed that the infection focuses are located in many states. In Italy, Spain, Germany, France and Great Britain, the number of the sick is still increasing very fast. The increase is the most dynamic in Spain, which suggests that the Spanish government and people ignored the already existing epidemic. There are not many cases of the sick in Great Britain, but, as we remember, the prime minister of that government decided to "come into collision with the virus".

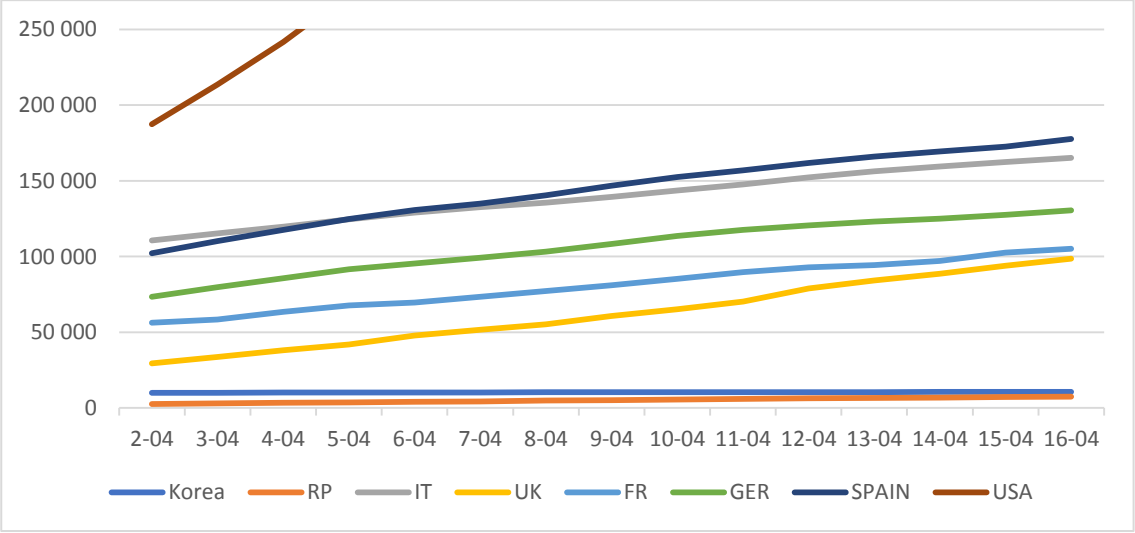

Chart 1.6. The sixth two-week period of analyses in the selected eight countries

On 16 April, in the USA, more than half a million of cases of the coronavirus were identified. Thus, the line which illustrated the situation in the USA "disappears" from the chart adjusted to the data in the remaining seven countries. A low number of those who contracted COVID19 is only found in Poland and in Korea. In the remaining 6 European countries, the number of identified cases is systematically increasing. The highest increase rate is in Great Britain.

The above 6 charts reflect unprocessed numbers in the form in which they were published by WHO and shown in the media. They present the media atmosphere of the epidemic outbreak relatively well, but this image is much distorted. The reality was different.

2 Taking the advice of dr House

The above method, with the use of six two-week periods, only approximately illustrates the development of the pandemic.

In order to present the beginning of the pandemic better, we have to:

1. take into account the size of the country to, inter alia, compare the situation in the USA with selected European countries and Korea.
2. evaluate and correct the statistical bias that occurs in collecting the data on the number of infected people and results from the limited possibilities of medical services.

2.1 Taking into account the size of the country.

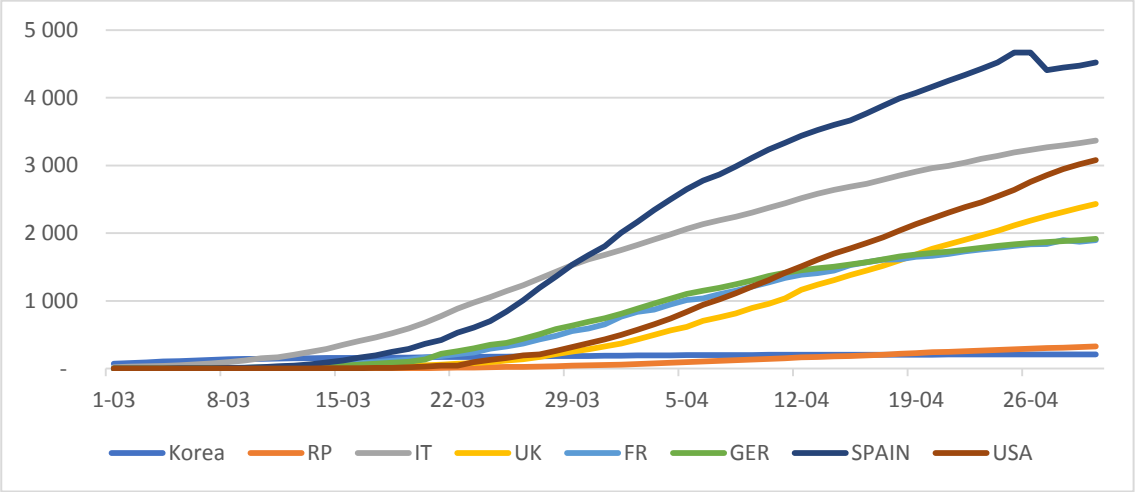

Chart 2.1. The number of people with COVID-19 in the selected 8 countries (calculated per 1 million of inhabitants).

From chart 2.1 we can clearly see that the most difficult situation is in Spain. Recently, the correction of data have been carried out there. The data collected in Great Britain and the USA is the most dynamic.

2.2 The correction of the statistical bias concerning the collected data

The data reported by particular countries is accompanied by the bias resulting from the limited possibilities of medical services.

When there are more and more people infected with the coronavirus, there is an increasing number of people who need hospitalization and quarantine, and there are not enough resources to test the ones who have no symptoms but may be infected.

According to charts 1.6, the number of people who contracted the virus within a week amounted to several dozen thousands. In such a difficult situation, tests can only be made for those who are sick and/or stay at hospitals. Thus, it is obvious that, within this group, the so-called apparent death rate(β) is much higher than when we analyse a representative group in a given country and we select the sick people from that group (death rate α). Along with the development of the epidemic and the increasing load of medical service, the value β (apparent death rate) is constantly increasing. In South Korea – to 2%, in Poland and the USA – to 5%, in France – almost to 20%. The results of the calculations for the selected countries were presented in chart 2.1

Table 2.1 The relation (β) between the number of deaths and the number of people infected with the coronavirus on 1 May in selected countries.

Country	Korea	RP	IT	UK	FR	GER	SPAIN	USA
Value β	2%	5%	14%	16%	19%	4%	11%	5%

Many epidemiologists assume the value of α = 1%. This is the value adopted in the further calculations. The higher the relation β/α, the more underestimated the number of infected people is.

Table 2.1. clearly shows that, if the reasons for deaths in particular countries were specified correctly, the number of people infected with the coronavirus in Korea, Germany, Poland and the USA may be several times as high as estimated, and in Spain, France, Italy and Great Britain it may actually be several dozen higher.

The following chart shows the relation between the number of people infected with the coronavirus, corrected for the value of the relation (β/α).

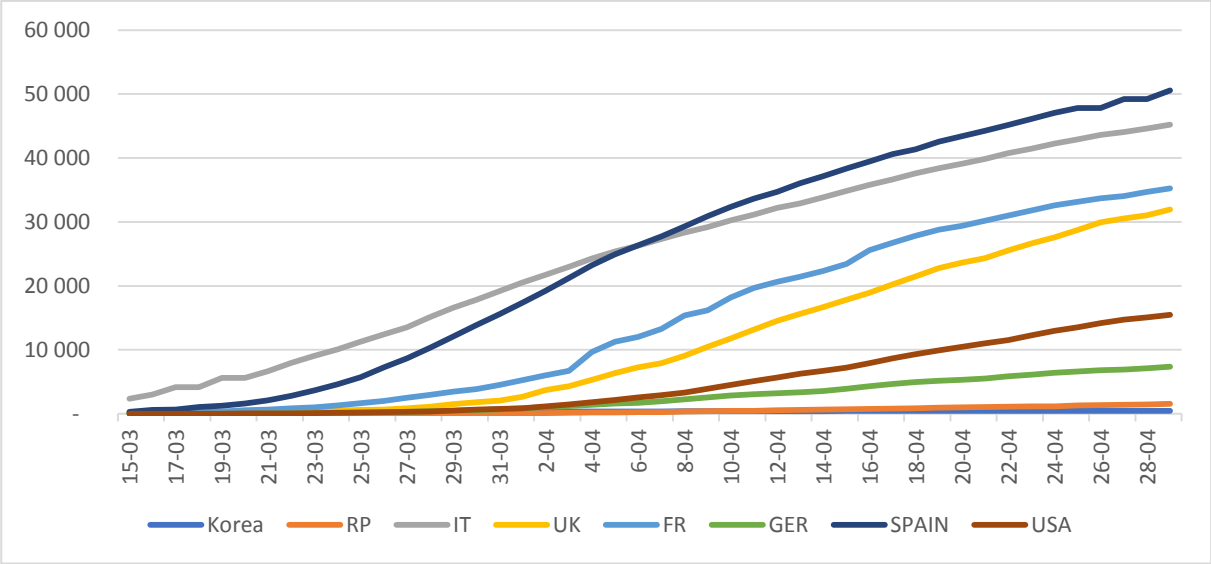

Chart 2.2. The number of people with COVID-19 in the selected 8 countries (calculated per 1 million of the inhabitants), corrected due to the lower efficiency of medical services in identifying the ones who contracted the coronavirus.

In the following chart, the corrected number of infected people calculated per one million of inhabitants, was given.

Table 2.2 The corrected share of people infected with the coronavirus per one million of inhabitants in the selected countries (on 1 May).

Country	Korea	RP	IT	UK	FR	GER	SPAIN	USA
Number of infected people	482	1 678	46 239	39 435	36 337	7 574	52 108	16 970

Due to linear approximation, on the basis of the above-mentioned relations we can predict that in June the number of infected people shall exceed the threshold of 10% in countries such as Italy, Great Britain, Spain and France. In these countries, the pandemic may approach the situation called collective immunity.

In the USA, Germany and Poland, another scenario is also possible, known from South Korea, but today we can estimate that, at the beginning of the new school/academic year, one in five students shall be infected with the coronavirus.

3 Dangerous image of the pandemic

On the basis of the data presented by WHO, we can also notice the dangerous image of the pandemic by establishing the relation between the number of deaths considered to be caused by the coronavirus

and the natural number of deaths (resulting from the average length of life). Irrespective of any doubts related to such calculations, the data forces us to draw some conclusions.

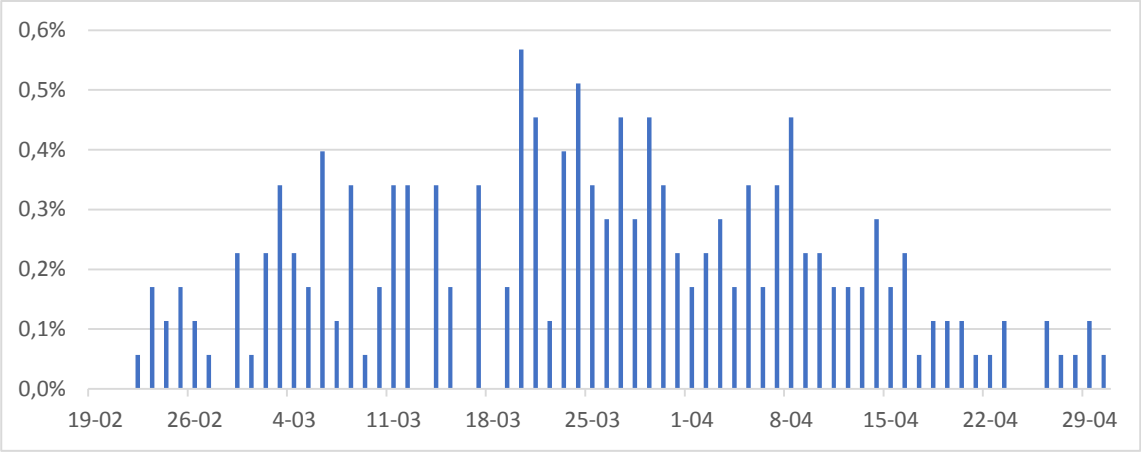

Chart 3.1. The relation between the number of deaths caused by the coronavirus and the natural number of deaths (resulting from the average length of life) in South Korea.

On the basis of the data from South Korea we can conclude that the epidemic in this country was much less dramatic than in other countries.

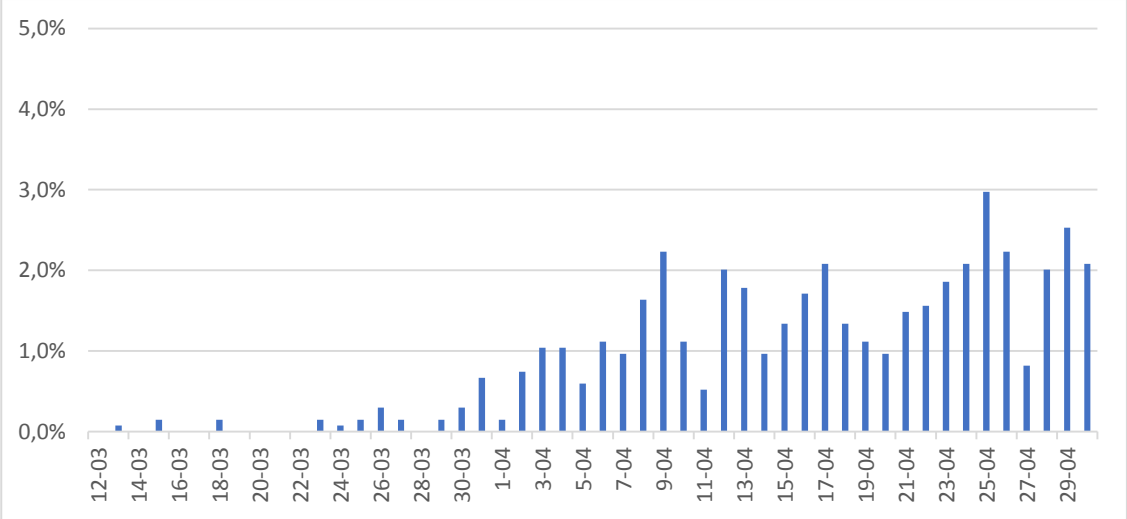

Chart 3.2. The relation between the number of deaths caused by the coronavirus and the natural number of deaths (resulting from the average length of life) in Poland.

The numbers that confirm the dramatic results of the pandemic in Poland are much higher than those from South Korea, but they are not increasing rapidly. It means that the government and the society should continue to prevent the development of the pandemic.

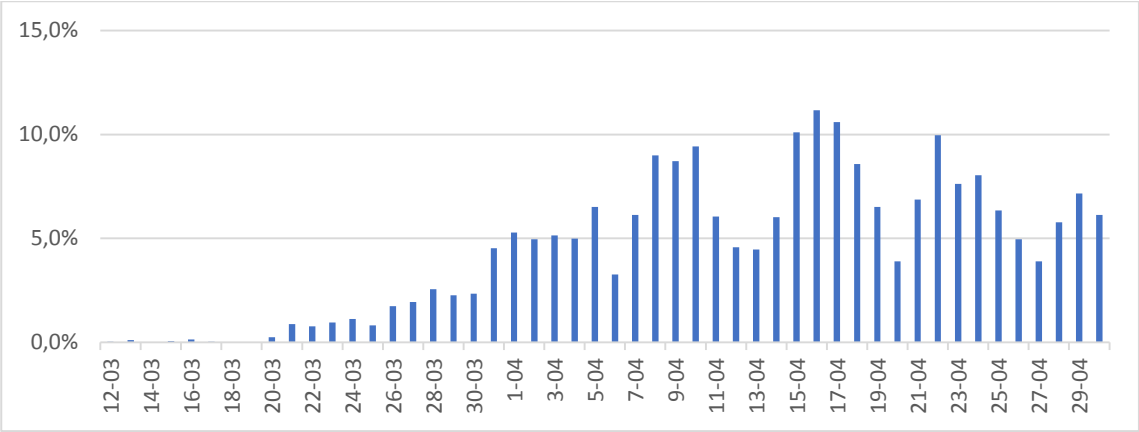

Chart 3.3. The relation between the number of deaths caused by the coronavirus and the natural number of deaths (resulting from the average length of life) in Germany.

The pandemic in Germany is more dangerous than in Poland, but its results seem to be effectively limited and they are not increasing rapidly. The situation in other countries is presented in Table 3.1.

Table 3.1 The share of the deaths caused by the coronavirus as compared to the average value of the expected deaths resulting from the length of life. The values are averaged within ten days, from 21.04 to 1.05. Additionally, in the same manner we calculated the percentage for the most extreme 10-day periods of the pandemic. For each country, that period could be different.

Country/ period	**Korea**	**RP**	**IT**	**UK**	**FR**	**GER**	**SPAIN**	**USA**
21.04-1.05	0.1%	2%	21%	28*	18%	6%	27%	17%
Extreme period	0.4%	2%	**39%**	**36%**	**44%**	8%	**53%**	18%

*) Value, without the correction, of 30-04 (WHO report no. 101).

In the above table we can clearly see the drama of the current situation (from 21.04 to 1.05) in Great Britain, Spain, Italy and France. However, comparing to the period of the maximum number of deaths in the above-mentioned countries, the situation is much better now. In Poland and in the USA the peak has not yet occurred, which took place in, e. g. Spain where almost a half of the deaths was considered to be caused by the coronavirus. Does this mean that we shall not experience such a dramatic situation and that we shall manage to keep the epidemic under control in the way it has been dome in South Korea? It is difficult to answer this question today.

Summary, or what is next?

For obvious reasons, the time of freezing the economy and social life described with the slogan: "Protect your life, stay at home" has to be replaced with the slogan: "Protect your life, act reasonably". We should hope that the past months were enough not only to transform the health service, but also to change our everyday habits. It is not easy, because our functioning in the time of the pandemic was totally different than it used to be. The development of the pandemic shall depend on how responsibly we will behave in everyday situations. There is another information included in the WHO reports that may be useful for us: the number people infected within 10 days, from 21 April to 1 May.

Table 4.1. The growth of the number of cases of the coronavirus with the 10-day period from 21 April to 1 May.

Country	**Korea**	**RP**	**IT**	**UK**	**FR**	**GER**	**SPAIN**	**USA**
Increase within 10 days	1%	34%	13%	37%	13%	11%	7%	34%

More than 30% increase in the number of the infected people in Poland within the last 10 days is a great challenge. Will our country remain an example of a reasonable behaviour of the government and the people? We shall see in the nearest future.

We should certainly change the way we teach and learn in schools and universities.

The author's note:

This text was written as an example mathematical task for students of humanist faculties, so that they can practice critical thinking. However, from the feedback, it can be concluded that the article has also been read by other recipients. Thus, in a month, I shall write another part of it.

Acknowledgement

I would like to thank my wife, Klaudia, for the inspiration and the idea of the title.

About the author.

In 2015, at the Faculty of Education of the Warsaw University, he obtained a doctor's degree with habilitation. In 2008, at the Faculty of Education of the Warsaw University, he obtained a doctor's degree in humanities. In 1977, at the Faculty of Physics of the Warsaw University, he obtained the degree of a Master of Physics. In the years 2014-2016, as the director of the Centre for Education Development, he implemented and published one of the world's largest educational resource in the Internet: epodreczniki.pl, which includes more than 50 handbooks for comprehensive education (from elementary education up to the secondary school finals). The system uses modern educational and IT techniques. The users may refer to the handbooks from various devices and operational systems. The handbooks can be accessed by individual students, as well as formal and informal student groups. Since 2016, he has been a professor of the Christian Theological Academy in Warsaw (ORCID 0000-0003-3360-3169, m.piotrowski@chat.edu.pl). More information: http://chat.edu.pl/kadra/dr-hab-marek-antoni-piotrowski-prof-chat/ and www.marekpiotrowski.eu.