

SEX-SPECIFIC DEATHS AND THE IMPACT OF THE COVID-19 PANDEMIC

**Ondřej Vít – Tomáš Löster – Lubomír Štěpánek – Stanislav Kováč –
Luboš Marek**

Abstract

Death probabilities predominantly rise with age, staying under 1% for men until age 59 and women until 67. While men display higher death probabilities across all ages, older generations of women experience a sharper rise than men. The similar death probability has sexes around hundred years old. In 2019, the primary age group for male fatalities was 70-74, comprising 16.5% of deaths, contrasting with 80-84 for women at 20.9%. COVID-19 profoundly impacted 2020 and 2021, contributing to over 36,000 casualties; males represented 57.2%. The death dynamics shifted: while the virus predominantly affected the elderly in 2020, younger fatalities became more prevalent in 2021. A year-on-year comparison reveals age group transitions for deaths, with a pronounced increase in death probabilities for older individuals in 2020. Notably, the mortality rates for causes other than COVID-19 remained consistent across 2019, 2020, and 2021. Thus, the surge in deaths was mainly attributable to the pandemic, which might have skewed life expectancy.

Keywords: Death probability, COVID-19 mortality, Causes of death

JEL Code: I12, I14, J11

Introduction

A person's sex is an essential socioeconomic variable, and significant differences between individuals of both sexes are also in the topic of death. Data of this type for the Czech Republic are collected and processed by the Czech Statistical Office. The article deals with the difference in mortality in terms of age and sex of deceased individuals and individual causes of death classified using the coarsest distribution of the ICD-10 classification (CZSO, 2023). Except for treating the situation as of 2019, described in detail in Vít (2022), the article adds changes observed in the pandemic years 2020 and 2021. The COVID-19 pandemic has strongly affected most of the world's countries, and there are numerous publications according to the country's specific conditions. Examples include Cemal and Masoyuki (2020) for Turkey and Lawal

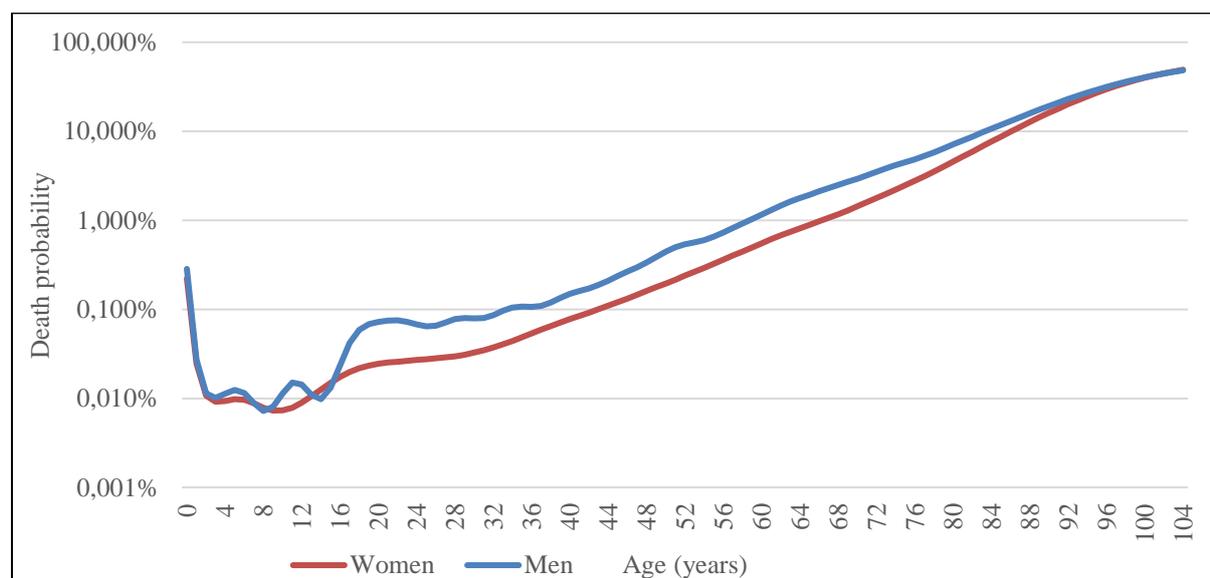
(2020) for Africa, which has a population structure that differs significantly from developed countries. The search for factors influencing pandemic mortality rates across countries and concerning other diseases was addressed by Sorci, Faivre, and Morand (2020). This article summarizes the situation of deaths and the impact of the pandemic on it in the Czech Republic in 2019-2021, with the primary division of the population by sex.

1 Death probabilities

The Czech Statistical Office compiles the death probability into life tables (CZSO, 2023) and complements the survival probability. The highest age in the life tables is 105, with a death probability 1. This subchapter primarily summarizes the death probability for both sexes in 2019, and the text describes that year unless otherwise noted in the text.

There were no apparent differences between the sexes in mortality rates at young ages in 2019, as the survival probability for both sexes, except at age 0, is higher than 99.9% by age 34. The survival probability steadily declines across increasing generations, and the increase in death probability is steep at the highest ages. The highest absolute difference between death probability curves was at age 88. At that age, the death probability for men was 3.2 p.p. higher in 2019 than women. In older generations, the curves for both sexes converged again.

Fig. 1: Death probability in 2019



Source: compiled by the authors

Figure 1 shows the higher death probability for men of all ages on a logarithmic scale. The rapid increase in male death rates occurs between ages 14 and 21, during which the death

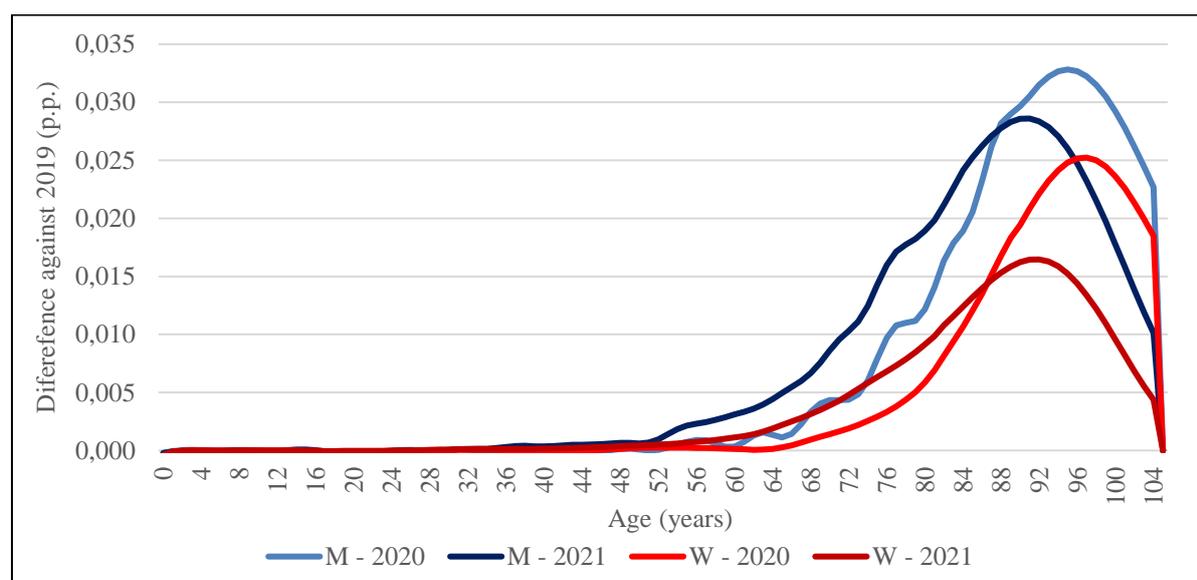
probability increases more than sevenfold. For women, the growth is much slower at this age. The chart shows the dangers of infant mortality. There is a significant difference in age at which an individual has a 1% death probability. While this is as early as age 59 for men, it is eight years older for women. At older generations, the curves in the graph are almost linear, suggesting a rapid exponential increase in the death probability in the age groups.

For given mortality rates, women had a life expectancy almost six years longer than men in 2019. While men had this statistic of 76.3 years in a given year, it was 82.1 years for women. The difference in this statistic has decreased linearly between the sexes in recent years. For women, the average annual increase between 2001 and 2019 was 0.2 years; for men, it was even 0.24 years.

In the years of the strong impact of the COVID-19 pandemic, i.e., 2020 and 2021, life expectancy for females declined by 0.72 and 0.87 years, respectively, for a total of 1.59 years, and for males, the declines were 1.03 and 1.21 years, for a total of 2.24 years. By 2022, life expectancy had returned to almost the 2019 values, reduced by about two-tenths of a year.

The decline in life expectancy in 2021 and 2022 was due to increased death probability in some age groups due to a higher number of deaths. Compared to 2019, when 112 362 people died in the Czech Republic, the number was 15.1% and 24.5% higher in 2020 and 2021. It is a significant difference compared to the annual increase in deaths, which was 0.6% for men and 0.4% for women in the past decade.

Fig. 2: Difference in death probability against 2019



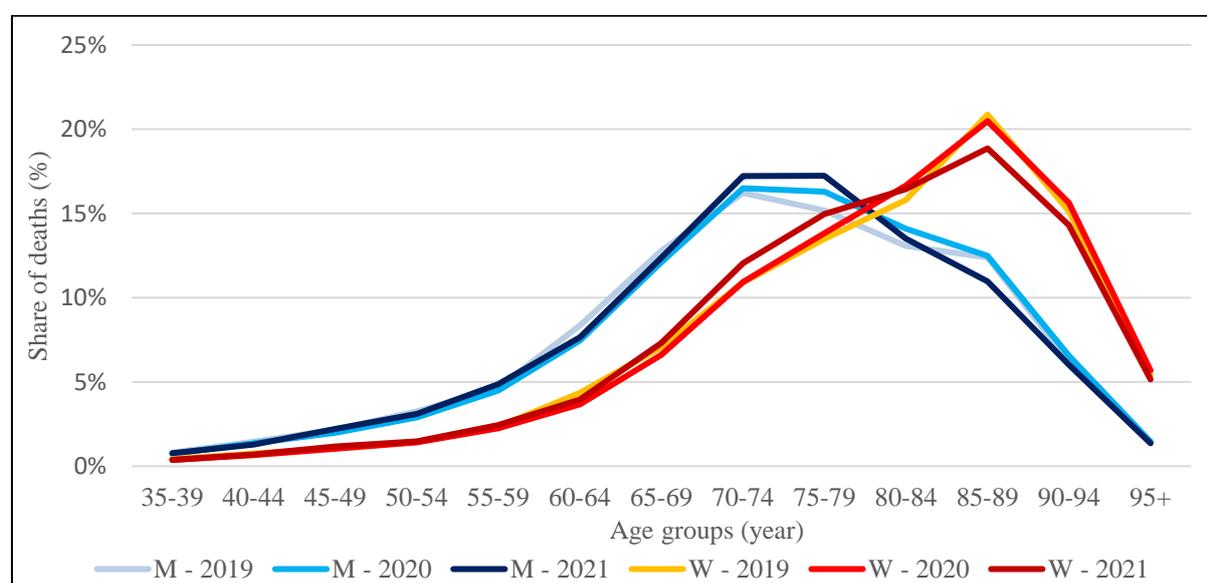
Source: compiled by the authors

Nominally, the probability of dying in 2020 and 2021 increased most at older ages. However, all death probabilities increased relatively similarly for ages from around 30 to 80 years. In both observed pandemical years, the nominal increase in the death probability across age groups was higher for males than females. As mentioned above, there were fewer deaths in 2020 than in 2021. The impact of the pandemic did not have the same effect on mortality in both years examined. Younger people were more likely to be affected in 2021, and the peak in nominal changes in death probabilities for both sexes is lower than in 2020. The death probability increased the most for 95-year-old men in 2020 by 3.3 p.p. and 2.5 p.p. for similarly aged women in the same year.

2 Causes of death

In the case of the death of an individual, the diagnosis group from which the individual died is determined according to the International Classification of Diseases (ICD-10). This classification is referred to in Roman numerals later in the text.

Fig. 3: Structure of deaths by age groups



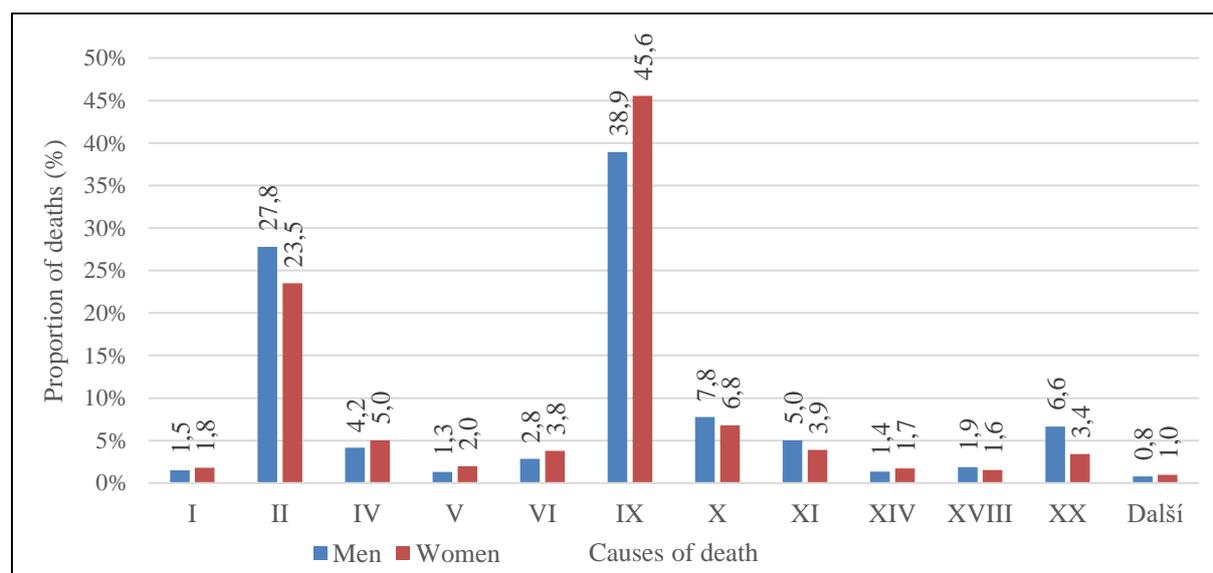
Source: compiled by the authors

In 2019, 112,362 people died, 51% of whom were male. It is a similar number of people and a similar proportion of males as for new births. This male share of deaths in subsequent years increased to 51.5% in 2020 and 52.6% in 2021. Figure 3 shows the distribution of deaths by age and sex in these three years. While most males (16.2%) died in 2019 between the ages of 70-74, females died most often (20.9%) between the ages of 85-89. The year 2020 for males

marked an increase in deaths in the 70-94 age groups at the expense of all younger age groups. Comparing 2021 with 2019, the proportion of deaths in males was higher in the 70-84 age groups at the expense of not only the younger age groups but also significantly so in the 85-89 age group. The situation is similar for women, although both pandemic years saw a reduction in the proportion of the modal age group of 2019, 85-89 years. Excluding this group, the share of the over-70 age group increased in 2020 at the expense of the younger age group.

Compared to males, there was a higher increase in the proportion of the over-90 age groups. In 2021, as with males, compared to 2019, the shares increased primarily in the 70-84 age groups. In addition, for women, the percentage also increased in the 65-69 age group. The most considerable difference was in the female age group 85-89, which decreased its share by two p.p. between 2019 and 2021.

Fig. 4: Deaths by causes in 2019



Source: compiled by the authors

The article analyses 11 out of 20 groups of diagnoses that were the cause of more than 99% of deaths in the Czech Republic in 2019, regardless of gender. This proportion of deaths caused by selected diagnosis groups is not constant between age groups. The selected diagnosis groups caused 98% or more of deaths in both sexes in all five-year age groups over 34 years, with a proportion above 80% for younger age groups except infant mortality. The average age of females and males dying in 2019 from one of these diagnosis groups was 79.3 and 72.6 years, respectively. These values are helpful for comparison with the average ages of death for each diagnosis. The distribution of deaths by cause of death is described only for 2019, and how the

distribution of causes of death changed in 2020 and 2021 represents the second part of the chapter.

Among the causes of death, diseases of the circulatory system (IX) and neoplasms (II) were dominant in both sexes. These two groups of diagnoses accounted for more than two-thirds of deaths in 2019. Diseases of the circulatory system (IX.) caused 45.6% of deaths in women and 6.6 p.p. fewer deaths in men. The average age of male deaths from a given diagnosis in 2019 was equal to 78.2 years, the highest among the eleven diagnoses. For women, the given period was only 4.5 years higher. The proportion of this cause of death increased in each age group, and in the 95-year-old and older age group, circulatory system diseases accounted for more than 60% of deaths, regardless of gender.

Neoplasms (II) were the second and last group of diagnoses, accounting for more than 10% of deaths in 2019. For women, they explained 23.5% of deaths, while for men, it was 4.3 p.p. more. In contrast to circulatory system diseases, the average age of death-caused neoplasms was below average for both men (71.3 years) and women (72.8 years). Among deaths in age groups, neoplasms have the highest proportion in women between 40-69 years. In these groups, neoplasms account for 40-50% of deaths, and overall, from age 30 to 74 years, neoplasms are the most common cause of death in women, but only in men from age 45-69 years. Neoplasms are a more frequent cause of death in men than in women in the age groups over 74 years, which comprise the majority of deaths, so overall, the proportion of this diagnosis is higher in men.

The third group of diagnoses with the most deaths in 2019 has this rank for both sexes. These are respiratory system diseases (X.), which caused 7.8% of deaths in men and 6.8% in women. Its share of deaths across age groups does not vary much, so the average age of those who died from this diagnosis is similar to the average age of deaths overall.

The fourth male and seventh female leading causes of death in 2019 were external causes of morbidity and mortality (XX). This diagnosis caused 6.6% of male deaths and only 3.4% of female deaths that year. This diagnosis was the most common cause of death at ages 1-44 years for males and 1-29 years for females. In the age groups over 70, the proportion of deaths due to this cause is in the teens, regardless of gender. The mean age of death from this diagnosis was 58.9 years for men and 71.2 years for women.

The fourth and sixth most common causes of death for women and men were diseases of the endocrine, nutritional, and substance metabolism systems (IV). This cause is more common in women than men. In women, it caused 5% of deaths in the year under review, compared with 4.2% in men. The proportion of deaths due to this cause increase with age, and

the average age of death is equal to 75.2 years for men and 81 years for women. Cause-specific death rates across age groups are almost identical for both sexes.

The sixth most common cause of death in 2019 was diseases of the digestive system (XI), the fifth most common cause for both sexes. This cause accounted for 4.5% of total deaths, 5% of male deaths, and 3.9% of female deaths. Males were more likely to die from this cause, and the average age of such males was 64.8 years, while for females, this average age was 72.4 years. This diagnosis affects younger people more often and has the highest proportion of deaths in the 30-59 age groups.

The seventh most common cause of death in 2019 was nervous system diseases (VI), which accounted for 2.8% of deaths in men and 3.8% in women in the year under review. The cause had a higher prevalence among causes of death in the under-20 age group. The average age of deaths due to this cause did not differ much from the average age of deaths overall.

The remaining four diagnoses accounted for between one and two percent of deaths in 2019. Symptoms, signs, and abnormal clinical and laboratory findings not elsewhere classified (XIII.) were more likely to cause death in men than women. The mean ages of deaths from this cause were below average for both sexes, with a difference of more than 12 years. This diagnosis caused the most infant deaths in a given year for both sexes. Certain infectious and parasitic diseases (I) caused 1.7% of deaths in 2019, more often in females. Mental and behavioral disorders (V.) accounted for 1.6% of deaths in 2019 and had a higher proportion of female deaths. This diagnosis was more likely to cause death with increasing age; therefore, the average death age for both sexes was among the highest. The eleventh observed diagnosis of diseases of the genitourinary system (XIV) was responsible for 1.5% of deaths in 2019 and more often caused deaths in women. The proportion of these diseases in deaths increased with age, and the average ages of fatalities from this diagnosis were among the highest.

2.1 Impact of the COVID-19 Pandemic

Deaths caused by COVID-19 have classification group XXII (specifically U07) reserved for exceptional situations. COVID-19 caused 36,000 deaths in the Czech Republic in 2020 and 2021. 70% of them died in the critical year of 2021. After subtracting deaths associated with this disease, the number of deaths in 2021 is very similar to that in 2019. For 2020, the number of deaths from a diagnosis other than COVID-19 is higher, possibly due to misrecording the cause of death at the beginning of the pandemic.

Males were more likely to be COVID-19 diseased than females, accounting for 57.2% of deaths from that cause, causing a significant skew in the proportion of males among fatalities

in 2021 when the share was equal to 52.6%. In 2020, the COVID-19 pandemic was the cause of 8.9% of male deaths and 7.3% of female deaths. These proportions varied considerably across age groups, with the disease having the highest share in the 75-90 age group. For older adults, the proportion was slightly lower but still close to the overall average, and for the younger, it fell towards zero, which was the case for age groups below 20 years. A similar distribution presents the Figure 3. In 2021, the proportion of deaths due to this disease was significantly higher, and while for men, it was the cause of 19.6% of deaths, for women, the share was 16.1%. The highest proportion is for the same age groups as described for 2020, but the percentage is significantly lower for older age groups. Younger age groups were more affected. This year also saw units of deaths in the youngest age groups.

The last section on causes of death assesses the relationship between COVID-19 disease and other causes. Koupaei et al. (2021) found an increase in mortality rates associated with tuberculosis classified as X, which might suggest a reclassification of deaths from respiratory diseases to COVID-19-related deaths. However, the authors argue that it is difficult to determine the cause of death in such cases, and classification errors can quickly occur. Since the disease affected people unevenly by age, it is possible that people would die from COVID-19 at the expense of other specific deaths, and the distribution of deaths by cause would change. On the other hand, the number of deaths from causes other than the pandemic did not change much, which would mean that COVID-19 killed individuals who would not otherwise have died in those years.

The changes in the proportion of single-cause deaths among those who died from a cause other than XXII are not sufficiently distinctive. The proportions of each cause in 2020 and 2021 were compared with their trends in 2009-2019. None of these proportions was statistically significantly different at the 5% significance level from the former trend. However, there is a decline in the proportion of respiratory diseases among women even though the primary cause of respiratory diseases increased from 2009 to 2019.

Conclusion

The death probability is an indicator that predominantly increases with increasing age. It remains below 1% for men until age 59 and women until age 67. Except for the higher values for men across almost all ages, there is a faster increase in the death probability values at older generations compared to women, with a leveling off only at the under-represented ages around 100 years. This difference leads to different modal age groups among the deceased. While the

dominant age group for males in 2019 was 70-74 years, with 16.5% of deaths, the dominant age group for females was 80-84 years, with 20.9% of deaths.

In 2020 and 2021, the country was affected by the COVID-19 pandemic, with over 36,000 deaths, of which males accounted for 57.2% of the diseased. The intensity of fatalities from the COVID-19 pandemic varied considerably between years, with males accounting for 8.9% of deaths and 7.3% of females in 2020, while in the following year, males accounted for 19.6% and females 16.1%. It was, therefore, the third most common cause of death after circulatory system diseases and neoplasms. Circulatory system diseases are more likely to cause death in women than men and are the most common cause in the over-75 age groups. On the other hand, neoplasms are more common in men and dominate other reasons in those aged between 40 and 60 years.

COVID-19 also rivaled these two causes of death due to similar typical ages of death. The pandemic has the highest proportion of deaths in women in the 65-89 age group and men aged 60-89. The years 2020 and 2021 differed in terms of COVID-19 deaths in number and age structure of death people because while in 2020, deaths were primarily among the elderly, in 2021, deaths at younger ages were more common than the year before. When comparing 2019 and 2021, there was a change in the male modal death age group from 70-74 years to 75-79 years and a weakening of the female modal group 85-89 years, with an increase in the proportion of deaths in the 70-79 years age groups. The highest growth in the death probability compared to 2019 was for males aged 95 years, who experienced a 3.3 p.p. increase in this probability in 2020. Females aged 97 experienced a 2.5 p.p. increase in death probability this year. In 2021, the maximum absolute differences in death probability were less significant than in 2020. However, there was a higher increase in that probability for both sexes under age 85.

We could not find a statistically significant relationship between COVID-19 and other causes of death, which in 2020 and 2021 had a similar representation among deaths from causes other than COVID-19 as in 2019. Thus, the deaths were almost net increased by COVID-19 diseased, leading to an increase in the probabilities of death for both sexes and the life expectancy calculated from them, which for 2022 almost returned to the 2019 values. As a consequence of the pandemic, there may be a falsely higher life expectancy due to the removal of the more medically susceptible individuals from the population, or conversely, a reduction in life expectancy due to the undermined health of experiencing COVID-19 disease, which manifests itself in respiratory problems.

Acknowledgment

This research was supported by the grant no. F4/53/2022 which has been provided by the Internal Grant Agency of the Prague University of Economics and Business.

References

- Bulut, C., & Kato, Y. (2020). Epidemiology of COVID-19. *TURKISH JOURNAL OF MEDICAL SCIENCES*, 50(SI-1), 563–570. <https://doi.org/10.3906/sag-2004-172>
- Classification MKN-10*. (n.d.). 6. Klasifikace. Retrieved 16 August 2023, from <https://www.czso.cz/csu/czso/6-klasifikace>
- Demographic Yearbook of the Czech Republic—2021*. (n.d.). Demographic Yearbook of the Czech Republic - 2021. Retrieved 16 August 2023, from <https://www.czso.cz/csu/czso/demographic-yearbook-of-the-czech-republic-2021>
- Koupaei, M., Naimi, A., Moafi, N., Mohammadi, P., Tabatabaei, F. S., Ghazizadeh, S., Heidary, M., & Khoshnood, S. (2021). Clinical Characteristics, Diagnosis, Treatment, and Mortality Rate of TB/COVID-19 Coinfectetd Patients: A Systematic Review. *Frontiers in Medicine*, 8. <https://www.frontiersin.org/articles/10.3389/fmed.2021.740593>
- Lawal, Y. (2021). Africa’s low COVID-19 mortality rate: A paradox? *International Journal of Infectious Diseases*, 102, 118–122. <https://doi.org/10.1016/j.ijid.2020.10.038>
- Sorci, G., Faivre, B., & Morand, S. (2020). Explaining among-country variation in COVID-19 case fatality rate. *Scientific Reports*, 10(1), Article 1. <https://doi.org/10.1038/s41598-020-75848-2>
- Vít, O. (2022). *Analýza vybraných ukazatelů v členění podle pohlaví v ČR*. Vysoká škola ekonomická v Praze.

Contact

Bc. Ondřej Vít

Prague University of Economics and Business

Nám. W. Churchilla 4, 130 67 Praha 3, Prague, Czech Republic

vito02@vse.cz

Ing. Tomáš Löster, Ph.D.

Prague University of Economics and Business

Nám. W. Churchilla 4, 130 67 Praha 3, Prague, Czech Republic

tomas.loster@vse.cz

Ing. MUDr. Lubomír Štěpánek

Prague University of Economics and Business

Nám. W. Churchilla 4, 130 67 Praha 3, Prague, Czech Republic

lubomir.stepanek@vse.cz

Ing. Stanislav Kováč

Prague University of Economics and Business

Nám. W. Churchilla 4, 130 67 Praha 3, Prague, Czech Republic

stanislav.kovac@vse.cz

prof. RNDr. Luboš Marek, CSc.

Prague University of Economics and Business

Nám. W. Churchilla 4, 130 67 Praha 3, Prague, Czech Republic

marek@vse.cz