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STRESZCZENIE ROZPRAWY DOKTORSKIEJ

Dyscyplina naukowa: Nauki o zdrowiu

Tytuł rozprawy doktorskiej:

Ekonomiczne i epidemiologiczne obciążenie umieralnością spowodowaną pandemią COVID-19

Streszczenie rozprawy doktorskiej:

In addition to its substantial public health burden, the COVID-19 pandemic generated significant economic consequences worldwide, including a decline in gross domestic product, rising unemployment, public finance imbalances, and loss of productive capacity. An appropriate approach to assessing the excess mortality burden caused by the pandemic should account for both the direct and indirect effects of COVID-19. As for the economic burden of the COVID-19 pandemic, one under-researched area is the estimation of productivity losses (indirect costs). While epidemiological studies assess the impact on health, productivity loss analyses translate these effects into economic terms by quantifying losses resulting from morbidity and premature mortality. Although these two approaches differ conceptually, together they provide a more comprehensive assessment of the societal burden of disease.

Aim of the study

The dissertation aims to provide an economic and epidemiological assessment of the mortality burden caused by the COVID-19 pandemic in 28 European countries in the years 2020-2023.

Materials and methods

The systematic review was conducted in accordance with the PRISMA guidelines. The review protocol was prospectively registered in the PROSPERO registry (registration number CRD42023478059). Medline, Embase, Scopus, Web of Science, EconLit, WHO COVID-19 Research, and EuropePMC databases were searched, along with grey literature sources. Population-level studies using secondary data were included. For quantitative cross-study comparison, losses were estimated in 2020 international dollars and as a share of gross domestic product.

In the epidemiological analysis, annual mortality data stratified by sex and 5-year age groups for the years 2002-2019 were used to predict mortality in 28 European countries (the European Union and Norway) for the years 2020-2023. Excess health burden was defined using three measures: excess deaths (eD), excess Years of Life Lost (eYLL), and excess Years of Potential Productive Life Lost (eYPPLL). Excess deaths were estimated by comparing observed and expected deaths and were subsequently used to calculate eYLL and eYPPLL.

In the economic analysis, retrospective Eurostat population-level data and a societal perspective were used to estimate productivity losses (indirect costs) in the formal and informal economy associated with mortality caused by the COVID-19 pandemic (excess deaths and COVID-19-attributable deaths) in 28 European countries (the European Union and Norway) during 2020-2023. For market losses, the Human Capital Approach (HCA) and the Friction Cost Approach (FCA) were applied. For non-market losses, the Opportunity Cost Approach (OCA) was used. In addition, the impact of mortality on public finance revenues was analysed.

Results

A total of 38 studies were included in the systematic review. The Human Capital Approach was the dominant method used in the studies (30 studies), while none applied the Friction Cost Approach. Most studies (84%) reported results on losses due to premature mortality, and one quarter provided estimates of losses caused by sickness-related absenteeism. In the 33 studies included in the quantitative comparison, productivity losses ranged from 0% to 2.1% of gross domestic product; the greatest losses were observed in high-

income countries and among individuals aged 40-59 years; losses among men accounted for approximately three-quarters of the total burden.

A total of 1,540,034 excess deaths were identified, corresponding to 16,695,365 eYLL and 1,997,095 eYPPLL. Central and Eastern Europe experienced the highest excess mortality burden, whereas the Northern countries were least affected. Sex differences were also observed, with men accounting for the majority of the burden (eD: 54.8%, eYLL: 58%, eYPPLL: 75%). In addition, the analysis revealed a pronounced age gradient. The main burden of excess mortality concerned individuals aged over 60 years, with the highest burden observed in the 85+ age group. From the perspective of eYLL, the burden shifted from the oldest age group to the 65-69 and 75-79 age cohorts.

Total productivity losses in the formal economy due to excess deaths in 2020-2023 across all 28 countries amounted to €57.6 billion under the HCA and €3.1 billion under the FCA. Productivity losses in the informal economy amounted to €72.5 billion, of which €19.6 billion was attributable to employed individuals and €52.9 billion to non-employed individuals. For COVID-19 deaths, productivity losses were lower: €35.0 billion under the HCA, €2.1 billion under the FCA, and €56.2 billion under the OCA (€12.4 billion among the employed and €43.8 billion among the non-employed). The highest relative economic burden was observed in Central and Eastern European countries and in the three Baltic states (Estonia, Lithuania, and Latvia). Losses were higher among men, particularly in the market economy (>80% of the total). Moreover, heterogeneous temporal patterns were identified across regions: Central and Southern European countries experienced the greatest losses in 2021, Western countries in 2022, and Northern countries in 2023.

Conclusions

1. Large scale of human losses: The pandemic resulted in 1.54 million excess deaths, translating into a loss of nearly 16.7 million excess Years of Life Lost. The year 2021 was associated with the highest burden, accounting for 41% of all excess Years of Life Lost.
2. Substantial economic costs: Total productivity losses in the formal economy amounted to €57.6 billion under the Human Capital Approach and €3.1 billion under the Friction Cost Approach. In the informal economy, losses reached €72.5 billion, demonstrating that the economic consequences extended far beyond the labour market.

3. **Profound regional inequalities:** Central and Eastern European countries and the three Baltic states (Estonia, Lithuania, and Latvia) bore a disproportionately higher epidemiological burden than Western and Northern Europe. In Central and Eastern Europe, the excess Years of Life Lost rate was three times higher than in the Nordic countries.
4. **Poland among the countries with the highest losses:** Poland was among the countries with the highest absolute epidemiological burden, with more than 213,000 excess deaths and 2.4 million excess Years of Life Lost identified, accounting for approximately 14% of the total years lost across the 28 countries analysed.
5. **Marked sex disparities:** The pandemic affected men disproportionately, both economically and epidemiologically, as they accounted for 82% of formal economy losses and 75% of excess Years of Potential Productive Life Lost.
6. **Loss of labour market potential:** Although most deaths occurred among older individuals, Europe experienced nearly 2 million excess Years of Potential Productive Life Lost. The greatest burden in this category was observed in individuals aged 40-59 years.
7. **The phenomenon of a “delayed peak”:** While the burden peaked in Central and Eastern Europe in 2021, countries such as Finland, Norway, and Sweden experienced the highest excess mortality burden only in 2023.
8. **Fiscal impact on public finances:** Excess deaths caused a reduction in public revenues (taxes and social contributions) amounting to €19.7 billion in total (under the Human Capital Approach), representing a significant burden for national budgets.