

HOSPITAL MEDICAL CARE AND THE COVID-19 MORTALITY IN METEOR PARTNER COUNTRIES (THE NETHERLANDS, BELGIUM, ITALY, AND POLAND)

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Abstract

Objectives: Healthcare systems in European countries, including METEOR partner countries, are faced with the aging population, an increase in costs for innovative technologies and medication, a shortage of health professionals, and inequality in access to healthcare. Presented paper aimed to recognize and compare the functioning of healthcare systems between METEOR partner countries and simultaneously check if the current epidemiological situation of COVID-19 has some relationship with the number of medical staff, yearly gross domestic product, or documented percentage of fully vaccinated people. **Material and Methods:** In the model of descriptive epidemiological study, available demographic, socioeconomic, and healthcare organizational data in the Netherlands, Belgium, Italy, and Poland were compared to the epidemiological situation of the COVID-19 pandemic (percentage of fully vaccinated people, incidence, and mortality) in all mentioned countries. **Results:** Obtained data confirmed that the lowest number of physicians, as well as the life expectancy and gross domestic product per capita, is in Poland. Simultaneously, the lower number of medical staff and lower gross domestic product (GDP) correspond to higher mortality due to COVID-19. The percentage of fully vaccinated with the last dose of the primary series was also the lowest in Poland. **Conclusions:** Obtained results confirmed that higher mortality due to COVID-19 in METEOR participants' countries is related to a lower number of medical staff and weaker GDP. The worse situation was noted in Poland, a country with problems in the functioning healthcare system, including hospital care and a serious shortage of practicing medical staff. *Int J Occup Med Environ Health.* 2023;36(3):417–27

Key words:

epidemiologic studies, COVID-19, SARS-CoV-2, medical staff, mortality rate, healthcare systems

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INTRODUCTION

The COVID-19 pandemic has proved to be a great challenge for healthcare systems worldwide. A challenging situation was related to hospital care due to staff shortages and initially limited access to personal protection equipment (PPE) [1,2]. As a result, medical staff experienced numerous and continuous traumatic events, which in many instances negatively affected their psychological well-being [3–5]. Some countries have chosen to involve medical students to support inpatient care [6–8]. Simultaneously, vaccines were the most promising approach to protect shortfalls in healthcare worker resources driven by SARS-CoV-2 infections, quarantine regulations, and emotional and physical exhaustion due to overwork as a consequence of co-workers' sick leave [9]. Available published data suggest that the vaccine significantly reduced morbidity, COVID-19 absenteeism, and duration of absenteeism among healthcare personnel in Greece [10]. However, the new publication documented, that nearly 25% of declared reactivity of COVID-19 vaccinations in medical workers led to ≥ 1 days of work loss [11]. It will be interesting to recognize if available registry data confirmed the existing relationship between the functioning healthcare system, available healthcare resources, the percentage of fully vaccinated against COVID-19, and registered morbidity or mortality in 4 European countries which are partners in the METEOR project.

METEOR is the European Union (EU) financed project realized in the Netherlands, Belgium, Italy and Poland. The consortium of project participants believes that obtained results help to recognize job retention determinants and the already successfully implemented practices of interventions and retention policies. The recent systematic review on the recruitment and retention of health professionals states that retention policies depend highly on economic, legal, political, and organizational determinants [12,13]. In the authors' opinion, obtained results

of the METEOR project can help medical staff retention in hospitals across Europe, especially in potential future pandemic crises. Healthcare systems in European countries, including METEOR partners countries, are faced with a wide range of similar challenges, such as [14]:

- the aging population and the increase of chronic diseases, which results in a higher demand for healthcare;
- an increase in costs for innovative technologies and medication;
- unequal distribution of health professionals, with shortages in some expertise fields and regions;
- inequality in access to healthcare, resulting in growing inequalities in health outcomes.

The presented paper aims to recognize and compare the functioning of healthcare systems between METEOR partner countries and simultaneously check if the epidemiological situation of COVID-19 has some relationship with the number of medical staff between countries, yearly gross domestic product, or documented percentage of fully vaccinated people against SARS-CoV-2. Such information will be useful for policy recommendations in public health. The authors believe, that obtained results help to understand the importance of the stability of medical staff employment in hospitals during a pandemic for the safety of patients. On the second hand, the authors expect that obtained results will allow them to answer the question of whether the recent crisis has exacerbated the phenomenon of medical workers' rotation. The more so newly published data suggest that the COVID-19 excess mortality rates varied in the region, one of the highest values was observed among others in Eastern and Central European countries [15]. Experts discussed observed spatial variability in many aspects such as mutation of the SARS-CoV-2 virus, testing capacity, quality, and comprehensiveness of systems for registering COVID-19 deaths, but also other factors including social, economic, and behavioral responses to the pandemic, including strict lockdowns.

MATERIAL AND METHODS

In the model of descriptive epidemiological study, the authors present available data revealing selected demographic, socioeconomic, and healthcare organizational factors in the Netherlands, Belgium, Italy, and Poland. Moreover, the authors analyzed available data on the epidemiological situation of the COVID-19 pandemic (percentage of fully vaccinated people, incidence, and mortality) in all mentioned countries. The authors used data available from the following sources, European Health Consumer Index (EHCI) [16], World Health Organization Health for All Database [17], the World Health Organization's Global Health Workforce Statistics, OECD [18], Worldometer [19,20], and WHO coronavirus (COVID-19) dashboard [22]. In the results section, the authors present available indicators in particular countries (Table 1 and 2).

Finally, the authors tried to compare whether the existing diversity of the included countries could be related to the higher mortality of patients with COVID-19. It was assessed correlation between reported total deaths due to COVID-19 per 1000 people and particular independent variables such as the percentage of fully vaccinated against SARS-CoV-2 with the last dose of the primary series in the 2022 year, total health expenditure as percentage of gross domestic product (GDP) *per capita*, the number of nurses and physicians per 1000 people, number of hospitals,

number of hospital beds number of acute care hospital beds and also the number of nurses or physicians newly graduated in a given year per 100 000 persons. It was used procedures available in the Excel package to calculate the Pearson correlation coefficient.

RESULTS

The EHCI index is a good starting point for assessing differences between healthcare systems in the 4 included countries. The EHCI compares European national healthcare systems based on indicators, including patient rights and information, access to care, treatment outcomes, range and reach of services, prevention, and use of pharmaceuticals. Currently, available data (2018) suggest that EHCI total score was the highest in Switzerland (893), the Netherlands (883), and Norway (857), followed by Belgium (849), Italy (687), and Poland (585), Hungary (565), Romania (549) and Albania (544) [16]. More detailed data describing scores within each sub-discipline of EHCI are presented in Table 1. The worst performance of the national health system compared to other METEOR project countries is in Poland. On the other hand, the latest WHO data confirmed that the number of practicing physicians and nurses varied by country [17,18]. Adequate data is pointed out in Table 2, which shows that in Poland the number of physicians per

Table 1. European Health Consumer Index (EHCI) noted in 2018 by particular METEOR partner countries

Variable	European Health Consumer Index			
	the Netherlands	Belgium	Italy	Poland
Patients' rights and information	125	104	92	79
Accessibility	175	213	138	138
Outcomes	256	244	233	167
Range and reach of services	125	115	73	57
Prevention	113	101	101	89
Pharmaceuticals	89	72	50	56
EHCI total score	883	849	687	585
Rank	2	5	20	32

Table 2. Selected available indicators in METEOR partner countries

Indicator	The Netherlands	Belgium	Italy	Poland
Population (2020) [n] [19]	17 135 000	11 589 000	60 461 000	37 847 000
Urban population (2020) [%] [19]	92.1	98.3	69.5	60.3
Hospitals (HFA-DB, 2013) [n] [17]	269	191	1135	1085
Acute care hospital beds [n/100 000 people] (HFA-DB, 2013) [17]	332	570	275	495
Hospital beds [n/1000 people] (OECD) [18]	3.2 (2018)	5.6 (2019)	3.1 (2018)	6.5 (2018)
Newly graduated in a given year [n/100 000 people] (HFA-DB, 2014) [17]				
nurses	39	47	22	28
physicians	14.6	11.5	11.7	9.6
Physicians [n/1000 people] (OECD) [18]	8.0 (2019)	6.0 (2019)	3.7 (2018)	2.4 (2017)
Nurses and midwives [n/1000 people] (OECD) [18]	11.5 (2018)	11.8 (2018)	5.9 (2015)	5.1 (2017)
The proportion of physicians working in hospitals [%] (HFA-DB, 2013) [17]	44	23.4	54.4	50.3
Life expectancy [years] (2020) [19]	82.8	82.2	84.0	79.3
GDP [USD <i>per capita</i>] (HFA-DB, 2020) [18]	52 300	44 594	31 676	15 656
Estimation of total health expenditure as a proportion of GDP [%] (HFA-DB, 2020) [18]	10.9	10.6	9.2	6.4
Reported total COVID-19 cases [n/1000 people] [20]	486.1	380.7	357.0	162.1
Reported total deaths due to COVID-19 [n/1000 people] [20]	1.31	2.77	2.89	3.09
Persons fully vaccinated with the last dose of the primary series [% of the total population] [21]	69.6	79.4	79.6	59.4

GDP – gross domestic product; HFA-DB – the Health For All databases; OECD – the Organisation for Economic Co-operation and Development.

1000 population is the lowest, as well as the life expectancy and gross domestic product *per capita*.

Table 3 includes values of Pearson's correlation coefficients in the relationship between reported total deaths due to COVID-19 per 1000 people and particular available and independent variables in selected countries. Obtained results suggest that a negative strong relationship was documented in the case of available medical staff numbers and GDP or total health expenditure. The lower number of physicians or nurses is related to higher mortality, $r = -0.88$ and $r = -0.65$, respectively. Moreover, a lower number of newly graduated physicians or nurses is related to higher mortality, $r = -0.94$ and $r = -0.39$, respectively. Simultaneously, lower GDP is related to higher mortality ($r = -0.78$). However, it is worth noting that no statistically significant values were obtained in any case, most likely due to the small number of compared pairs of data.

DISCUSSION

The healthcare system in METEOR partner countries differs in the range of access to healthcare and adopted funding sources which could result inter alia in the observed inequalities in health. Belgium is based on social health insurance which covers the entire population. It combines compulsory, comprehensive, and universal public health insurance with freedom of choice and independent medical practice [22]. The mandatory health insurance scheme covers significant risks for the whole population and min. risks for 90% of the population [23]. Belgium spends a relatively high proportion of its GDP on health (10.7%), and nearly 80% of health spending is publicly funded [24]. With relatively high public spending on health, households' out-of-pocket payments amounted to 18.2%, and low-income people declared highly unmet medical care needs, resulting in growing inequalities. More recent,

Table 3. The correlation coefficient in the relation between total deaths due to COVID-19 and particular independent variables in selected countries

Determinant	Total deaths due to COVID-19	
	R	p
Number of hospitals	0.62	0.38
Acute care hospital beds (per 100 000 people)	0.39	0.61
Hospital beds (per 1000 people)	0.59	0.41
Physicians (per 1000 people)	-0.88	0.12
Nurses and midwives (per 1000 people)	-0.65	0.35
Newly graduated in a given year (per 100 000 people)		
physicians	-0.94	0.06
nurses	-0.39	0.61
GDP (USD <i>per capita</i>)	-0.78	0.22
Estimation of total health expenditure as a proportion (%) of GDP	-0.66	0.34
Persons fully vaccinated with the last dose of the primary series (% of the total population)	0.01	0.99

GDP – gross domestic product;

available statistics suggest that the number of hospitals has been declining steadily since 2013, in 2021 Belgium had 163 of them. Additionally, health expenditure *per capita* was at level EUR 4 272 in 2020. On January 13, 2023, deaths due to the coronavirus in Belgium amounted to level 33 478 [25].

Current healthcare in Italy is provided by a mixed public-private system [26]. Out-of-pocket expenditure in Italy (in 2019) was 23.3%, which was significantly higher than the EU average [17]. Healthcare spending in Italy accounts for 9.2% of Italy's GDP, implying an average of EUR 2437 per inhabitant. As in other European countries, access to healthcare in Italy is relatively good and life expectancy is one of the highest among the EU inhabitants [27]. By analogy, the current number of hospitals in Italy somewhat decreased in the last 10 years (from 1119 in 2014 to 1048 in 2020) and health expenditure per capita was at level EUR 2833 in 2021. The cumulative number of COVID-19 deaths as of May 11, 2023, was 190 056 [25].

Life expectancy in Poland remains the lowest in the compared countries, not exceeding 80 years (in 2020). Unfor-

tunately, the COVID-19 pandemic reduced average life expectancy by 1.3 years in 2021 compared to 2015–2020 [28] as in other countries. The current healthcare system in Poland was developed due to reforms conducted in 1999–2004 and the mandatory public health insurance contribution, paid to the National Health Fund (Narodowy Fundusz Zdrowia – NFZ), has become the primary source of public funding, financing about 85% of the cost of public purchase of healthcare services [29]. The Polish healthcare system has been experiencing severe difficulties for many years, mainly due to one of the lowest public spending (6.4% of GDP in 2020 while WHO recommended a minimum of 7% of GDP to ensure patient safety) [30] and the high value of out-of-pocket expenditure (20.4% in 2019). The last data suggest that the number of hospitals in Poland not much has changed since 2013, in 2021 there were 1237. Health expenditure *per capita* was PLN 4569 (about EUR 1020). The cumulative number of COVID-19 deaths as of January 11, 2023, was 118 615 [25].

The Dutch health system features a mix of competitive insurance for curative care, a single-payer system for long-

term care, and locally organized tax-funded systems, in which the government plays a substantial role [31]. Health insurance in the Netherlands is mandatory and is covered by 2 statutory forms of insurance: basic insurance and long-term nursing and care. Healthcare spending by the Netherlands accounts for 10.2% of the GDP, which implies EUR 3967 per capita in 2019 year. Government regulation guarantees universal and equal access to quality care, covering about 99.9 % of the population. Out-of-pocket spending also stands below the EU average. This implies that access to the health system is one of the best in the EU, with almost no differences in unmet needs between socioeconomic groups. Nevertheless, waiting times and workforce shortages have increased, potentially threatening accessibility. The healthcare system in the Netherlands counts 8.0 practicing physicians per 1000 inhabitants [32]. More recent, available statistics suggest that the number of hospitals has increased steadily since 2013, in 2021 the Netherlands had 618 of them. Additionally, health expenditure per capita was at level EUR 7116 in 2021. On January 13, 2023, deaths due to the coronavirus in the Netherlands amounted to level 22 992 [27].

As the authors mentioned above, healthcare systems in METEOR partner countries are varied in many factors such as the type of organization, budget, and availability of medical staff. This is especially important in the case of existing health crises, which undoubtedly the COVID-19 pandemic was. From the beginning of the pandemic, it was observed significant differences in the registered incidence and mortality of patients. Available data presented in Table 2 suggest that the number of new cases in August 2022 was the lowest in Poland but simultaneously the mortality was the highest [20]. It is worth indicating that inter alia the aging population and shortage of medical staff significantly limited access to expected healthcare which have created growing external pressures on physicians. Poland had 2.4 practicing physicians per 1000 inhabitants, and 5.1 nurses for every 1000 inhab-

itants [18]. Inefficient use of time due to administrative requirements, the loss of autonomy at work, and decreased control over the work environment with a low average salary of general practitioners (EUR 30 740 per year) play a significant role in developing mental distress and intention to leave a job [33]. That observation is somewhat different than those observed in Japanese psychiatric nurses [34] or Switzerland employees of hospitals [35] in which the major determinants of intention to leave and job satisfaction were workloads and job stress. Available registries of mortality due to COVID-19 in the entire population and selected independent variables of a healthcare system in particular countries allow for assessing the strength and direction of the possible dependency. Obtained results confirmed a strong and negative correlation (however not statistically significant) between the number of medical staff (physicians and nurses) and mortality ($r = -0.88$ and $r = -0.65$, respectively). This observation is in line with those noted in Hubei, China [36] where the number of medical staff had significant negative effects on the coronavirus disease mortality rate. It is a surprisingly positive correlation coefficient in this study between the total number of deaths due to COVID-19 and the number of hospitals or hospital beds per 1000 people, 0.62 and 0.59, respectively. Previously quoted paper [36] rather shows an inverse relationship. It cannot be ruled, that such an effect could be the result of the small number of data used in the calculation (data from only 4 countries was compared). Simultaneously, it is difficult to understand why a relationship between the percentage of fully vaccinated people and total deaths due to COVID-19 ($r = 0.01$) have not been observed. Current data suggest that the frequency of being fully vaccinated was similar in Belgium and Italy, respectively, 79.4% and 79.6% of the total population. In the Netherlands completed vaccination has 69.6% of inhabitants. The percentage of fully vaccinated people in Poland is the lowest and amounts to 59.4% [21]. Newly published data confirmed that COVID-19 vaccina-

tion strongly protects against COVID-19-related hospital admission in patients with and without comorbidity [37]. Some explanation of this phenomenon should be an effect of spurious correlation, the Pearson's coefficient was calculated for only 4 pairs of data and the obtained value is not statistically significant. However, it is worth noting that the smallest percentage of vaccinated in Poland is accompanied by the highest mortality rate. The reported number of deaths due to COVID-19 per 1000 people varied by country. Poland had 2–3 times higher number of deaths than other countries (the Netherlands, Italy, and Belgium). However, the number of newly registered coronavirus cases in Poland was over twice lower as in compared countries (162.1/1000 people). It cannot be excluded that a low percentage of vaccinated people is responsible for higher mortality due to COVID-19 in Poland, and additionally, it should be considered that the number of people infected with SARS-CoV-2 is certainly much greater than the officially recorded number of incidents. The procedures for tracking the epidemic and testing citizens have not been robust and extensive enough to detect all or almost all infections [38].

On the other hand, a significant shortage of medical staff (physicians and nurses) is observed in Poland, which may affect the deterioration of medical staff work in hospitals. Additionally, the number of hospital beds per 1000 population remains high with an insufficient number of medical staff. Available published data suggest that the global COVID-19 mortality rates are likely affected by multiple factors, including hospital resources, personnel, and bed capacity. Higher-income countries have more significant intensive care units (ICU), acute care, and hospital bed capacities [39]. The situation was alarming in December 2022, when hospitals were under tremendous pressure in which they did not be unable to treat all patients and would be forced to triage based on medical and non-medical characteristics of the patients [40]. Other observations confirmed that variances in healthcare systems'

organization, particularly ICU capacity and admission criteria, combined with a rapidly spreading pandemic might be different outcomes treatment in coronavirus disease 2019 between countries [41]. Belgian experiences documented that adopting an extended definition of "COVID-19-related deaths" in the context of limited testing capacity has provided timely information about the epidemic's severity [42]. Italian study confirmed that differences in testing availability and capacity, containment, overall health care, and medical infrastructure result in significantly different mortality rates and COVID-19 case numbers for the country [43]. Moreover, results of the National Research Council of Italy analysis suggest that the best-performer countries to cope with the COVID-19 pandemic crisis have a smaller population and/or better public governance associated with high expenditures on the health system [44].

The COVID-19 crisis revealed that healthcare systems functioning in all countries around the world have some weaknesses, including a not sufficient number of involved medical staff. Significant shortages of physicians and nurses in hospitals may result in a worsening of patients' safety as well as in the worsening of the mental health of active workers. International cooperation in the METEOR project has become an opportunity to check whether the different healthcare systems, their different financing, and organization had any impact on the incidence and mortality due to COVID-19 in partner countries. It was assumed that a lower number of medical staff employed in hospitals and less total health expenditure are related to the higher value of both ratios. However, obtained results confirmed, that only mortality could be related to the number of physicians or nurses per 1000 population. On the other hand, it was observed that lower GDP is related to higher mortality due to COVID-19 which is in line with well-known published data. It should be strongly emphasized that the recent epidemiological crisis observed around the world revealed

significant differences in the health situation between countries. As some authors pointed medical staff who worked in departments of infectious diseases, internal medicine, and diagnostics were significantly overloaded, while other medical professionals, such as dentists or dermatologists, faced considerably reduced demand for their services [45]. The CDC's mitigation strategy suggests that maintaining appropriate staffing in healthcare facilities is essential to providing a safe work environment for medical staff and safe patient care [46]. The Health and Human Services report underlined, that higher-than-normal turnover rates of medical staff were a driving factor behind staffing shortages in hospitals during the pandemic. Experts concluded that improving training in medical education programs and optimizing existing workforce development programs will help hospitals and other sectors avoid future workforce shortages [47].

Strengths and limitations

A strength of the presented paper is the novelty of aimed problem, to the authors' knowledge, no studies are showing the problem of differentiated healthcare systems concerning the observed COVID-19 mortality.

A weakness of the work is its descriptive character, authors compare secondary epidemiological data available in official registers, which often refer to a different year. However, the authors believe that showing a certain type of health map in 4 European countries (with different health care systems and the wealth of the population) is necessary to develop recommendations that are common for the region, which will be held to understand the phenomenon of shortage of medical staff and help to minimize its consequences.

CONCLUSIONS

Obtained results confirmed that higher specific mortality due to COVID-19 in METEOR participants' countries is related to a lower number of medical staff and weaker GDP. The worse situation was noted in Poland,

a country with problems in the functioning healthcare system, including hospital care and a serious shortage of practicing medical staff.

Author contributions

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