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Original article

DISTRICT-LEVEL VARIATION IN COVID-19 VACCINATION RATES AND AVAILABILITY OF VACCINATION SERVICES IN BULGARIA

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ABSTRACT

Purpose: Since early 2022, the COVID-19 vaccination rate in Bulgaria has remained low, with large regional differences. This study examines the association between the availability of vaccination sites and the number of administered doses, and the extent to which district-level variation is attributable to differences in vaccination services provision.

Materials and Methods: Data on COVID-19 vaccine doses administered by districts were used. This data set was combined with district-level information on available vaccination sites, such as general practitioners and temporary vaccination points. The district-level differences in vaccination coverage and service provision were illustrated through country heat maps, and the association between the variables was explored using two linear regression models.

Results: According to the first regression model, the number of general practitioners and temporary vaccination points accounted for only 3.8% of the district-level variation in administrated doses. As covariates in the second model, sociodemographic and economic data were included. The combined influence of these factors explained 42.2% of the variance across districts. According to the findings, the average annual gross wage is a significant determinant of the district-level differences in the number of administrated doses.

Conclusion: There is no statistically significant association between administered doses and vaccination sites by districts, which does not correspond to the findings of other international studies. District-level variation in vaccination rates is associated with some sociodemographic and economic differences. The paucity of district-level data impedes further analyses of the vaccine coverage differences and their underlying determinants.

Keywords: vaccination rates, general practitioners, temporary vaccination points, districts,

INTRODUCTION

Since the onset of the COVID-19 pandemic, the approval of vaccines has been a turning point in the fight against the virus [1], and their rollout has been considered as important as their development and approval. In November 2020, the World Health Organization (WHO) published a guide to support countries in developing national vaccination plans and meeting the challenges of the world's largest mass vaccination campaign. According to the recommendations, national strategies for vaccination against COVID-19 should be tailored to the health system characteristics and country-specific context [2].

COVID-19 vaccine deployment at the national level requires a vaccination delivery strategy that determines facilities and structures for providing COVID-19 vaccines (vaccination sites). During the various stages of the vaccination campaign, there are many differences across and within countries. For example, in the United Kingdom, vaccines were initially administered in hospital hubs and primary care centres and later in general practitioner surgeries, community pharmacies, and large vaccination centres[3].

When planning vaccination sites, not only the capacity of health workers and facilities is considered, but also their location. Various methods and techniques have been utilised to identify appropriate locations, such as mathematical models, artificial intelligence, image processing, machine learning methods, geospatial programs, and verbal definitions[4]. Significant attention is paid to the ease of access for particular target groups, especially the elderly, people with disabilities, residents of remote areas, and other vulnerable groups.

Vaccine delivery and uptake are crucial to the success of the COVID-19 vaccination programme; however, despite the efforts made and the well-known fact that immunisation programmes have prevented millions of deaths annually [5], achieving high vaccination coverage against COVID-19 has been hampered in many countries. Previous epidemics have revealed obstacles that hinder vaccination and deteriorate disease control. These barriers are provisionally grouped into two categories: structural and attitudinal [6]. People's beliefs or perceptions can reduce their willingness to vaccinate, while the most common structural barrier is related to physical access, considered as geographical and functional proximity to vaccination sites. Active involvement of primary health care professionals, particularly general practitioners (GP), has been recommended as a successful strategy for administering the COVID-19 vaccine with the potential to overcome the abovementioned barriers[7].

The vaccination campaign in Bulgaria started on December 27, 2020. According to an order of the Minister of Health, the vaccines were administered by physicians in hospitals and outpatient healthcare facilities, Regional Health Inspectorates, mobile vaccination teams, and, if necessary, by medical specialists in Centres for Emergency Medical Services and medical offices at schools, kindergartens and social institutions [8]. In February 2021, by order of the Minister of Health [8], GPs were also involved in the vaccination campaign. Gradually, the number of temporary vaccination points increased: from 318 in February 2021 to 366 by the end of the year.

Nonetheless, since early 2022, the vaccination coverage in Bulgaria has been well below the targets, with large differences among the districts. The aim of this study is to examine the association between the availability of vaccination sites and the number of administered doses and the extent to which district-level variation is attributable to differences in vaccination services provision.

MATERIALS AND METHODS

Data on the COVID-19 vaccine doses administered by districts between the beginning of the vaccination campaign on December 27, 2020, and December 31, 2021, were used. The number of administered doses is not identical to the district-level vaccination rate; however, it was used as a proxy indicator due to the lack of information on residents with completed vaccination. Data were retrieved from the National Health Information System by request to the Ministry of Health (Decision No. RD 01-129 from March 10, 2022, on granting access to public information). This data set was merged with district-level information on vaccination infrastructure, i.e. available vaccination sites, including GPs and temporary vaccination points set up by other healthcare providers. The National Health Insurance Fund provided district-level data on the number of GPs (Decision No. RD 19-83 from April 11, 2022, on granting access to public information). According to the Order No. RD-01-1040 of the Minister of Health on determining the outpatient and inpatient health care facilities and Regional Health Inspectorates where COVID-19 vaccines may be administered [8], the number of temporary vaccination points as of December 21, 2021, were estimated by districts. Using data from the National Statistical Institute (NSI) for 2021, the district-level number of vaccination sites and administered doses were weighted with the population [9].

In order to explore the association between the availability of vaccination sites and COVID-19 vaccination coverage, both variables were included in the analysis. The district-level distribution of vaccination sites and provided doses per 10,000 population was depicted on country heat maps. In addition, the association between the variables was examined using linear regression models after accounting for district population weights. The first model related the number of administered doses to the availability of vaccination sites. The second regression model was adjusted with sociodemographic composition and socioeconomic status variables retrieved at the district level by the NSI (proportion of rural population, ratio of population aged 65+ to population aged 15-64, and average annual gross wage). In the second model, all continuous variables were normalised to represent the number of administered doses deviation for a one-standard-deviation change in the factor. Both models provided standard estimates for every predictor. Statistical analyses were performed using *jamovi, version 2.2.5*. The regional distribution was illustrated through *Excel 2019 Bing app*.

RESULTS

As of December 31, 2021, there were 366 temporary vaccination points in Bulgaria and 3,940 GPs. Figure 1 shows the district-level distribution of vaccination sites (combined number of GPs and temporary vaccination points per 10,000 population).

From the beginning of the vaccination campaign to the end of 2021, 3,683,893 doses were administered in Bulgaria. Out of the 28 districts, the most doses were provided in Sofia-capital(969,004), followed by the districts of Plovdiv (355,549) and Varna (258,104). The number of COVID-19 administrated doses per 10,000 population by districts is presented in Figure 2.

Fig. 1. Vaccination sites per 10,000 population by districts, 2021

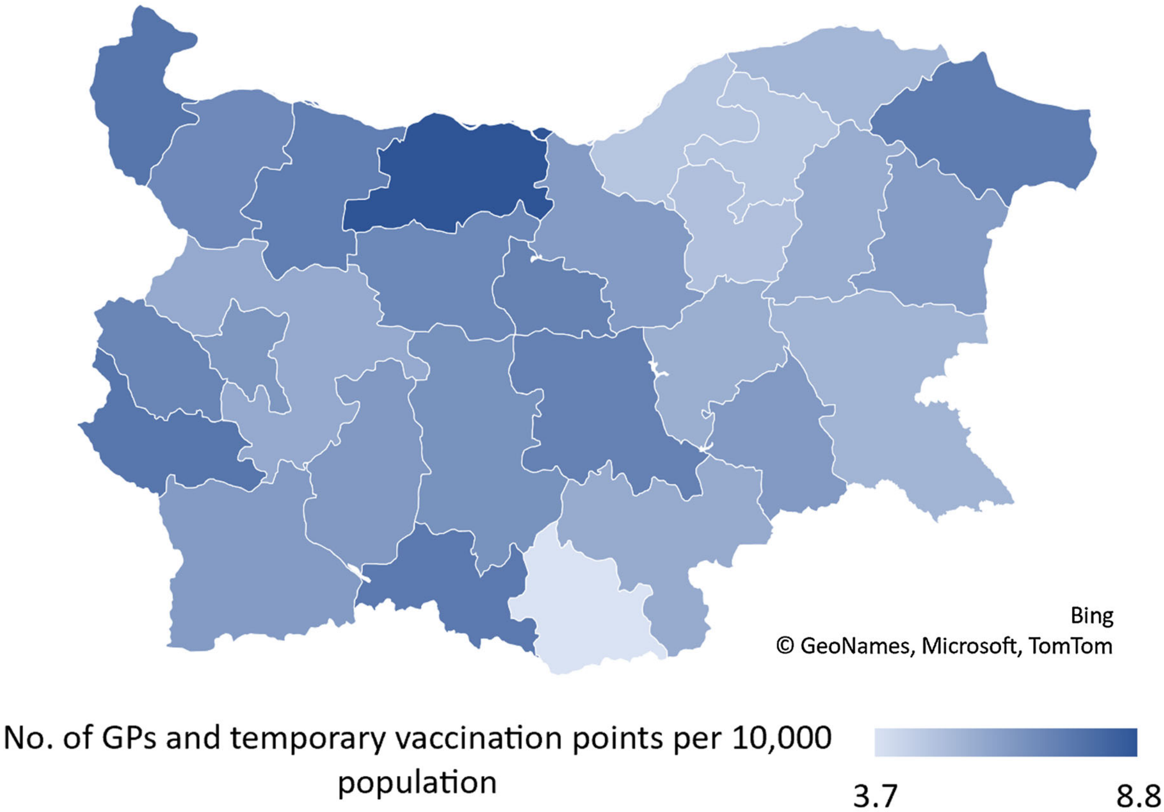
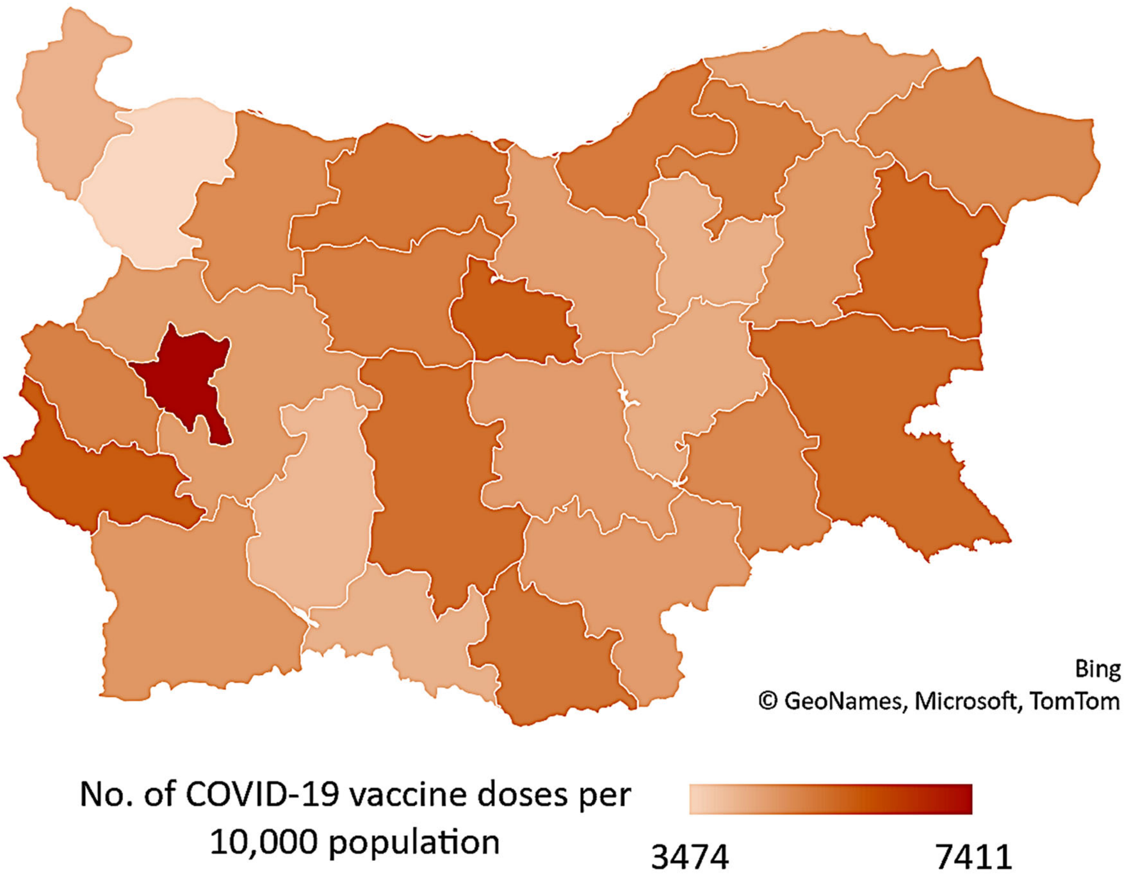


Fig. 2. COVID-19 vaccine doses per 10 000 population by districts, December 31, 2021



According to the first regression model, there is no statistically significant association between administered doses and vaccination sites by districts (Table 1, Model 1). Only 3.8% of the district-level variance in COVID-19 vaccine doses can be attributed to the number of GPs and temporary vaccination points(adj. R^2=0.038). The result assumes that if additional vaccination points were provided, vaccination coverage would not normally increase. However, such a district-level analysis does not take into consideration the accessibility of services in different settlements, which does not rule out the possibility that an increase in the number of vaccination points could have a more significant effect on vaccination rates in particular areas.

The second model includes sociodemographic and socioeconomic data at the district level as covariates (Model 2, Table 1). These factors collectively explain 42.2% of the variation in administered doses across districts (adj. R^2=0.425). The effect of the number of vaccination sites per 10,000 people on district-level variation is marginally greater after adjustment but still insignificant. The second model reveals that higher vaccination rates are associated with a lower proportion of rural residents and a higher district-level average wage. According to the results, the average annual gross wage significantly affects the disparities in COVID-19 vaccine doses administered between districts. In conjunction with the other covariates, a one-standard deviation increase in annual salary (BGN 2,253) is associated with an increase in vaccination rates of 0.514 standard deviations or roughly 375 doses per 10,000 populations (p=0.013, Table 1). Similar significant associations are found in stratified analyses between the number of administered doses and annual salary at the district level. A higher level of education may also contribute to a higher vaccination rate. Nonetheless, this association cannot be proven due to a lack of data at the district level.

Table 1. Regression models of variation in COVID-19 vaccine administrated doses by districts

Variables	**Model 1**			**Model 2**		
	SE	*t*	*p*	*SE*	*t*	*p*
Vaccinationsitesper 10,000 population (2021)	0.019	0.097	0.924	0.133	0.666	0.512
Proportion of rural population, % (2021)	-	-	-	-0.365	-1.931	0.066
Ratioofpopulationaged 65 + topopulationaged 15-64, % (2021)	-	-	-	0.090	0.435	0.667
Averageannualgrosssalary, BGN (2020)	-	-	-	0.514	2.695	0.013
Adjusted R^2	0.038			0.425		

Notes: N=28 districts. Vaccination sites are estimated based on the number of GPs and number of temporary vaccination points by districts

DISCUSSION

A number of studies have highlighted the importance of GPs in running successful campaigns and implementing vaccination programmes, including those against COVID-19 [10].In many countries, GPs are patients' first contact point with the health system. Although their roles vary, they are essential players in implementing vaccination strategies [11, 12]. In France, GPs administered 90% of vaccines [13], and in New South Wales, Australia, around 65% [14]. In Belgium, GPs were involved in the different stages of the vaccination campaign, not only directly in vaccine administration but also as key facilitators in communication and building COVID-19 vaccine confidence [15]. Israel fully vaccinated more than half of its residents in less than six months, which was coordinated through primary health care plans and GP practices [16]. As of February 12, 2022, the EU had recorded vaccination coverage of approximately 74.3%; however, this average covered significant variations among member states: from 93.6% in Portugal to 29.8% in Bulgaria [17]. Despite the proven safety and efficacy of vaccines and the benefits of vaccination, Bulgaria lagged behind all other EU countries.

The findings of our study revealed that GPs and temporary vaccination points had no significant effect on the number of doses administered. One possible reason was a vaccine shortage at the beginning of the campaign. During the initial stages, which targeted certain priority groups, so-called "green corridors" were introduced, allowing all adults outside of priority groups to receive the vaccine at temporary vaccination points. This decision caused controversy amongGPs, who argued that administering vaccines through the "green corridors" resulted in a shortage of doses for their patients.

The inclusion of primary health care professionals, such as GPs, provides an opportunity to enhance equality and address gaps in adult vaccination against COVID-19 [7] and suggests that many people will prefer to receive the vaccine at their regular physician's practice. The recommendation from a medical specialist is strongly associated with vaccine acceptance [18]. In a 2021 Kaiser Family Foundation survey, three in 10 adults who were hesitant at the time reported that they were more likely to receive the vaccine during a routine physician visit [19]. Regarding our study, these findings are not fully confirmed in Bulgaria. Compared to the other EU Member States, the COVID-19 vaccination rate remains much lower.

The low vaccination rate can also be attributed to the attitudinal barriers relating to awareness, vaccine confidence and general health literacy. In 2020 and 2021, some regular health services were suspended, and access to medical specialists, including GPs, was restricted. People frequently obtained information about the COVID-19 vaccine from unofficial sources, and the impact of misinformation was significantly greater. At the peak of the pandemic, in-person visits were replaced by teleconsultations in many cases. According to a poll conducted by Eurofound in the winter of 2021, 29.6% of Bulgarian respondents claimed that they had consulted a medical specialist online or by phone. In addition, over 30% of respondents were concerned about the risk of contracting the virus in healthcare facilities, pointing to fear of infection as a reason for deferring or refraining from medical examination or treatment [20]. Moreover, the promotion of vaccine effectiveness and safety was somehow neglected by medical specialists due to the increased workload caused by the escalation of COVID-19 morbidity.

In general, during the early stages of the vaccination campaign, more emphasis was placed on vaccine logistics and delivery than on attitudes towards COVID-19 vaccination. Consistent messages addressing vaccine hesitancy remained outside the campaign's focus. This contributed to widespread misconceptions and false information about vaccine safety, resulting in a high level of vaccine hesitancy and reluctance.

The current study has several limitations. Given the lack of publicly accessible data, only a restricted set of sociodemographic and socioeconomic factors at the district level were included in the model. Significant characteristics, such as educational attainment, that could explain variance in the number of administered doses have not been included. In addition, data on the vaccination sites by the end of 2021 were used; however, the number of temporary vaccination points expanded progressively throughout the year, and at a later stage, the GPs were involved. Furthermore, it is not certain whether all GPs administered vaccines and participated in the campaign. This may also affect the district-specific availability of vaccination services. Finally, the number of administered doses is not entirely identical to the vaccination rate. Two-dose vaccines are the most commonly used in Bulgaria; however, it is likely that single-dose vaccines predominate in some districts, resulting in fewer doses administered but a higher number of people vaccinated.

CONCLUSION

Although mass vaccination has been recognised as the most effective measure in combating the COVID-19 pandemic, achieving high vaccination coverage has become a distant dream in Bulgaria. Expanding access to the COVID-19 vaccine by sites and times seems to have no apparent effect on vaccination coverage. District-level variation in vaccination rates is associated with some sociodemographic and socioeconomic differences; however, awareness, attitudes, and perceptions of COVID-19 vaccines require significantly more attention. The experience of Bulgaria demonstrated the need for an integrated approach in vaccination campaigns addressing simultaneously structural and attitudinal barriers to access.

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