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Effectiveness of BNT162b2 vaccination in preventing COVID-19–associated death in Poland

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What's new?

This is the first report on the course of vaccination programme in Poland. It comprehensively describes the vaccination rate and effectiveness of BNT162b2 vaccine in preventing COVID-19 deaths. It`s main strength is inclusion of all Polish citizens and use of publicly available information from governmental databases. Such approach ensures the validity of our analyses

and allows to draw valuable conclusions for further research and management of ongoing vaccination programme. COVID-19 related mortality is estimated.

ABSTRACT

Introduction: The development of COVID-19 vaccines was the turning point of the ongoing pandemic. The Aim of this study is to describe the course of vaccination programme in Poland and effectiveness of BNT162b2 vaccine.

Objective: The aim of study was to analyze vaccination rates and effectiveness stratified by age groups in Poland.

Patients and methods: This is a retrospective study based on the data on vaccination rate and survival status among Polish citizens obtained from registries kept by the Polish Ministry of Health, the Statistics Poland and the European Centre for Disease Prevention and Control. The data were collected between week 53 of 2020 and week 3 of 2022. The final analysis included patients who were either not vaccinated at all or fully vaccinated with the BNT162b2 vaccine.

Results: The database contained records of 36,362,777 individuals among whom 14,441,506 (39.71%) were fully vaccinated with the BNT162b2 vaccine and 14,220,548 (39.11%) were not vaccinated at all. The weekly average effectiveness of BNT162b2 vaccine on preventing death was 92.62% and varied from 89.08% for ≥80 year olds to 100% for individuals at 5-17 years of age. The mortality rate was significantly higher in unvaccinated group compared to the fully vaccinated group in the entire cohort (447.9 per 100 000 vs. 43.76 per 100 000, $P<0.001$) in all age categories.

Conclusions: Results of the study confirm high effectiveness of BNT162b2 vaccine in preventing COVID-19 deaths in all analyzed age groups.

Key words:

COVID-19 Vaccines, COVID-19, COVID-19 epidemiology

INTRODUCTION

Vaccines are judged as the one of the most valuable and effective tools in prevention of infectious diseases and their sequalae, including disability and death. WHO estimates that globally vaccinations prevent 3,5-5 millions of deaths every year [1]. Vaccines are not only tools applied to maintain health and well-being of population, but also are an effective measure used in tackling disease outbreaks.

One of the most spectacular examples of vaccine importance is the current COVID-19 pandemic. The development of messenger RNA (mRNA) vaccines against COVID-19 provided health care systems with new measures to combat pandemic on global scale. Clinical trials have shown extraordinary performance of these vaccines against symptomatic COVID-19 reaching 95% for BNT162b2 and 94.1% for mRNA-1273.214 vaccine [2,3] at early stage of the pandemic. Altogether, the introduction of universal vaccinations significantly changed the course of the ongoing pandemic and could have prevented approximately 14.4 millions of COVID-19 deaths worldwide between December 2020 and the end of 2021 [4].

So far, there are no available reports on the performance of the vaccination programme in Poland. Therefore, we used the publicly available databases to evaluate the rate and effectiveness of BNT162b2 vaccine in Polish population including stratification by the age groups. To paint a more complete picture we investigated the temporal trends in the number of fully vaccinated individuals and mortality in fully vaccinated and unvaccinated people.

MATERIAL AND METHODS

Study design and setting

This is a retrospective study based on the anonymized data on vaccination and survival status among Polish citizens provided by the Polish Ministry of Health, the Statistics Poland (a governmental office responsible for collecting and publishing statistical data on a national level) and the European Centre for Disease Prevention and Control (ECDC) [5,6,7]. The data were collected between week 53 of 2020 and week 3 of 2022. Overall, there were 76,733 deaths registered among patients diagnosed with COVID-19 in all groups in the analyzed period. The structure for the Polish population was assessed for 31th of December 2020.

Study population

The final analysis included patients who were either not vaccinated at all or fully vaccinated with the BNT162b2 vaccine. Patients who were only partially vaccinated (received one dose of BNT162b2 vaccine) or were vaccinated with a vaccine different than BNT162b2 (i.e. ChAdOx1, Ad26.COV2.S, mRNA-1273) were excluded from the final analysis concerning vaccine efficiency. The study flowchart is presented in **Figure 1.**

Data sources, definitions and study groups

The available information about patients who died included date of death, sex, age, vaccination status and additionally for those who were vaccinated: type of vaccine, number of administered doses and exact dates of vaccinations. Study database also included weekly reported data on vaccination status stratified by age (provided by ECDC) and data on general population of Poland stratified by age groups (provided by Statistics Poland). Patients were divided into fully vaccinated and not vaccinated groups. Patients were considered as fully vaccinated 2 weeks after administration of the second dose of an two-dose vaccine, or two weeks after administration of a single dose vaccine. In each group, the data was further

divided according to age (5-9, 10-17, 18-24, 25-49, 50-59, 60-69, 70-79, ≥80 years), week of the year and the time from full vaccination to death.

Timeline of vaccination programme in Poland

The COVID-19 vaccination programme in Poland began on December 27th 2020. Initially, vaccines became available for medical staff employed in hospitals, outpatient clinics, long-term care facilities and pharmacies, hospital administrative workers, medical students and individuals employed in medical universities. Later, on January 15th 2021 registration for vaccinations was introduced for patients aged ≥80 years in the general population. Since then, vaccinations became gradually available for younger Polish citizens until May 10th 2021 when registration for vaccination became open for all adult Poles. Moreover, in February 2021 all teachers and people employed in the educational sector were included in the vaccination programme and in March 2021 registration was opened for patients with selected chronic diseases (chronic renal failure requiring dialysis, chronic respiratory failure requiring long-term mechanical ventilation, cancer and recent chemo- or radiotherapy, history of organ, tissue or cells transplant).

Statistical analysis

Categorical variables were presented as counts (percentage) while continuous variables were presented as means (standard deviation, SD). Differences in mortality between the groups were evaluated using chi square test or Fischer exact test as appropriate.

The risk of primary outcome, i.e. COVID-19 associated death, was determined separately for each week and stratified by the study group and the above mentioned age categories. The risk of death was measured as the mortality rate i.e., we divided the number of people who died due to COVID-19 by the number of people in a given study group and age category in an analyzed week.

Vaccine effectiveness (VE) was measured by calculating the risk of death, and determining the percentage reduction in death's risk among vaccinated persons relative to unvaccinated subjects. The greater the percentage reduction of deaths in the vaccinated group, the greater the vaccine effectiveness. The basic formula is written as:

VE= (Risk among unvaccinated group − risk among vaccinated group/Risk among unvaccinated group) x 100%

Additionally, we analysed the time of death in relation to the BNT162b2 vaccination time. Finally, the number of potentially avoidable deaths was estimated by subtracting the number of deaths that would have occurred in the non-vaccinated group if the mortality rate was equal to mortality rate in the vaccinated group from the actual number of deaths in the non-vaccinated group.

All statistical analyses were conducted with the Microsoft Excel 2022 (Microsoft, Redmond, USA) and R Studio (R project, Vienna, Austria).

RESULTS

Study sample and vaccination status

The entire database contains 36,362,777 individuals among whom 21,151,732 (58.17 %) were fully vaccinated. Study participants received full vaccination with BNT162b2 (14,441,506; 68.28%), ChAdOx1 (2,630,452; 12.44%), Ad26.COV2.S (2,550,103; 12.05%) and mRNA-1273 (1,529,671, 7.23%). **Figure 2** presents temporal trends in vaccination status for all vaccines (**A**) and BNT162b2 (**B**). **Figure 3** presents the proportion of vaccines administered throughout the study period presented in weekly intervals.

Vaccine effectiveness

Over the entire period studied, the BNT162b2 vaccine achieved an weekly average effectiveness of 92.62% in preventing COVID-19 deaths and varied from 89.1% ≥80 year

olds to 100% for individuals at 5-17 years of age. **Table 1** summarizes the total BNT162b2 VE stratified by the age groups. **Figure 4** depicts the 4-weeks average effectiveness of the BNT162b2 vaccine stratified by the age groups.

COVID-19 mortality and vaccination status

There were 6,643 deaths as a result of COVID-19 in all age groups of people vaccinated with BNT162b2 vaccine. The mean age at the time of death was 78.64 years. The group of people who died included 2,854 women (mean age 79.8 years) and 3,789 men (mean age 77.7 years). Among the unvaccinated, there were 64,812 deaths as a result of COVID-19 (mean age 75.0 years), including 30,577 women at the mean age of 77.7 years, 34,073 men at the mean age of 72.7 years and 162 cases with undetermined gender at the mean age of 69.5 years.

Figure 5 presents the temporal increase in number of deaths in the vaccinated group over the weeks following acquirement of full vaccination status. This shows a gradual loss of protection following vaccination.

DISCUSSION

The aim of this retrospective, registry-based study was to evaluate the vaccination rate and the effectiveness of BNT162b2 vaccine between 2021 and 2022 in Poland. During the study period, the vaccination rate was almost 60% with majority of individuals being vaccinated with BNT162b2. We showed that the weekly average effectiveness of BNT162b2 vaccine in preventing COVID-19 death was very high and accounted to 92.6%. It varied significantly depending on the age group and ranged from 89.1% in individuals >80 years old up to 100% in patients aged 5-17 years. We estimated that 100% vaccination rate could have saved approximately 60 thousand additional lives. Our results suggest that vaccinations are an effective way of preventing death, even in populations with moderate vaccination rate.

One of the most important determinants of vaccination programme effectiveness is the vaccination rate. Among European Union countries it varies significantly and ranges from 30.0% in Bulgaria to 86.6% in Portugal. The genesis of such vast differences in the national compliance is multifactorial and includes the capacity of healthcare system, the quality of national campaign of vaccine promotion, the government attitude towards vaccines and level of national health awareness and education. The achievement of good vaccine coverage during COVID-19 pandemic was additionally hindered by numerous organizations and public figures raising doubts and fear about the safety of COVID-19 vaccines among the public. Unfortunately, Poland remains one of the countries with the lowest vaccination rates in the European Union despite wide availability of vaccine doses. Our analysis shows that the vaccination rate was the highest in individuals aged 60-79 years and decreased gradually with the age. Similar trends were observed nearly uniformly in other countries. This is most likely related to higher risk of severe COVID-19 among elderly patients and therefore stronger motivation to protect oneself.

Our observation concerning vaccines effectiveness in preventing COVID-associated death covers the data from other countries which have similar or higher vaccination rate. The study carried out in Scotland that was based on an analysis of 114 706 cases of SARS-CoV-2 infection between April and September 2021 indicated that BNT162b2 vaccine was 90% effective in preventing deaths in people who have been double vaccinated [8]. In USA during Delta wave in October-November 2021 unvaccinated persons had 12.7 times higher death risks in comparison with fully vaccinated persons [9]. Also Qatar study confirmed the high level protection – 93.4% - against COVID-19 associated death in 2021 after BNT162b2 double vaccination [10].

In the analyzed period all available vaccines were based on the original coronavirus strain from Wuhan, China, which raised the question of their effectiveness against various

variants of SARS-CoV-2, in particular the Alpha and Delta variants since they differ significantly from the original strain. Both, Alpha and Delta variants were designated as Variants of Concern (VOC) by the WHO. Compared with the original Wuhan strain, the Alpha variant (B.1.1.7) has 23 mutations with 8 which are in the virus's spike protein. Three of them thought to have the largest potential biological effect such increased coronavirus S protein binding to ACE2 cell receptor and immune response evasion [11]. The Delta variant (B.1.617.2), which firstly appeared in India, has 23 mutations compared to the Alpha strain with a unique set of mutations. Two of them allow the variant to attach more firmly to ACE2 receptors, while others may allow Delta to evade host immunity. In summary, these mutations make Delta variant up to 60% more transmissible than the Alpha variant, and exceptionally infectious and evading from neutralizing antibodies in previously infected or vaccinated people [12,13,14].

Due to such differences, especially concerning the Delta variant, one would expect that the effectiveness of vaccines against them will also be lower. Actually, both BNT162b2 and ChAdOx1 vaccines have been recorded to have reduced effectiveness in the individuals infected with the Delta variant compared to the other VOCs. The VE of two doses of the BNT162b2 vaccine was 93.7% in people with the Alpha variant compared to 88% in people with the Delta variant [15]. Although two doses of the mRNA vaccines effectiveness to prevent COVID-19 associated hospital admissions was exactly the same - 85% - against both Alpha and Delta variants, mRNA vaccines differed with their ability to prevent peoples against COVID-19 associated deaths related to these two variants. For example, among patients admitted to hospital with COVID-19, mRNA vaccine effectiveness (two doses) to prevent progression to invasive mechanical ventilation or death was 76% for the Alpha variant, while for the Delta variant it was only 44% [16,17]. However, other papers presented different results, i.e. according Nasreen et al. VE against severe outcomes after two doses of

BNT162b2 estimates above 90% against both Alpha and Delta variants [18]. Generally, there was noted 5-fold death cases increase among peoples infected with Delta variant than Alpha after two dose BNT162b2 vaccination [18]. In comparison to Alpha wave in Poland we have noted 3-5-fold death cases increase in fully vaccinated subjects during the Delta wave depending on age which is in line with above statement.

The effectiveness of vaccines depends not only on the coronavirus variant, but also on the age of the vaccinated people. It is known that in older persons the response to immunization decreases with age [19,20,21,22] and from this reason COVID vaccines effectiveness against symptomatic infection is generally lower for older adults (≥60 years) than for younger adults (<60 years) for most of the VOC [18]. In our paper we also highlight the decline in people's response to the BNT162b2 vaccine with age, with a gradual increase in the percentage of deaths especially in the ≥80 years old group. Similar results are reported by Sheikh et al .; during the Delta wave the percentage of death cases ≥14 days after two dose BNT162b2 vaccination were 0% for age group 18-39, 0.06% - 40-59 years old and 1.23% in group above 60 years old [8]. One must however notice that, despite gradual decrease of vaccine effectiveness with age, it remains very high and accounts to 93.0% in the oldest age group.

This is the first report on the course of vaccination programme in Poland. It comprehensively describes the vaccination rate and efficiency of BNT162b2 vaccine in preventing COVID-19 deaths. It`s main strength is inclusion of all Polish citizens and use of publicly available information from governmental databases. Such approach ensures the validity of our analyses and allows to draw valuable conclusions for further research and management of ongoing vaccination programme. We are aware of several limitations of this study. First, the database did not include data on booster doses which could potentially lead to overestimation of vaccine effectiveness in our study. Second, the data on side effects of vaccination were not available, therefore we were unable to include this important aspect in

our paper. Third, due to limited testing for COVID-19 the number of infections and COVID-19 deaths could have been underestimated. Fourth, we decided only to report data on BNT162b2 vaccine to avoid overcomplication of the manuscript. This decision was based on the fact that nearly 70% of fully vaccinated individuals in Poland received BNT162b2. Finally, due to registry-based design of the study we were unable to include some potentially important variables, such as comorbidities and genetic variant of the virus, in the analysis.

In this retrospective analysis based on registry data of all Polish citizens we confirmed that despite only moderate vaccination rate, the BNT162b2 vaccine provided an excellent protection from COVID-19 death. This observation was consistent in all age groups however there was an evident decline in vaccine effectiveness in older individuals. Considering the large estimated number of lives already saved by vaccines in Poland, we strongly believe that effort should be put in further promotion of vaccination programme in our country to prepare the healthcare system for upcoming waves of pandemic.

Contribution statement: All Authors meet the following criteria:

- substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; and
- drafting the work or revising it critically for important intellectual content; and
- making the final approval of the version to be published; and
- they agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of interest: None declared.

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REFERENCES

1. World Health Organization. Vaccines and immunization [Internet]. www.who.int. World Health Organization; 2020. Available from: https://www.who.int/health-topics/vaccines-and-immunization#tab=tab_1
2. Polack FP, Thomas SJ, Kitchin N, et a. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. N Engl J Med. 2020 Dec 31;383:2603-2615..
3. Baden LR, El Sahly HM, Essink B, et al. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. N Engl J Med. 2021 Feb 4;384:403-416.
4. Watson OJ, Barnsley G, Toor J, et al. Global impact of the first year of COVID-19 vaccination: a mathematical modelling study. Lancet Infect Dis. 2022 Sep;22:1293-1302.
5. Data on COVID-19 vaccination in the EU/EEA [Internet]. European Centre for Disease Prevention and Control. 2021. Available from: https://www.ecdc.europa.eu/en/publications-data/data-covid-19-vaccination-eu-eea
6. Publicly available data from Polish Ministry of Health Information Service on COVID-19.
7. Data on Polish demographics [Internet] Statistics Poland. Available from: https://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/ludnosc-stan-i-struktura-ludnosci-oraz-ruch-naturalny-w-przekroju-terytorialnym-stan-w-dniu-31-12-2020,6,29.html
8. Sheikh A, Robertson C, Taylor B. BNT162b2 and ChAdOx1 nCoV-19 Vaccine Effectiveness against Death from the Delta Variant. N Engl J Med. 2021 Dec 2;385:2195-2197.
9. Johnson AG, Amin AB, Ali AR, et al. COVID-19 Incidence and Death Rates Among Unvaccinated and Fully Vaccinated Adults with and Without Booster Doses During

Periods of Delta and Omicron Variant Emergence - 25 U.S. Jurisdictions, April 4-December 25, 2021. MMWR Morb Mortal Wkly Rep. 2022 Jan 28;71:132-138.

10. Tang P, Hasan MR, Chemaitelly H, etal. BNT162b2 and mRNA-1273 COVID-19 vaccine effectiveness against the SARS-CoV-2 Delta variant in Qatar. Nat Med. 2021 Dec;27:2136-2143.
11. Walker AS, Vihta KD, Gethings O, et al.Tracking the Emergence of SARS-CoV-2 Alpha Variant in the United Kingdom. N Engl J Med. 2021 Dec 30;385:2582-2585. .
12. Shiehzadegan S, Alaghemand N, Fox M, Venketaraman V. Analysis of the Delta Variant B.1.617.2 COVID-19. Clin Pract. 2021 Oct 21;11:778-784.
13. Planas D, Veyer D, Baidaliuk A, et al. Reduced sensitivity of SARS-CoV-2 variant Delta to antibody neutralization. Nature. 2021 Aug;596:276-280.
14. Mlcochova P, Kemp SA, Dhar MS, et al. SARS-CoV-2 B.1.617.2 Delta variant replication and immune evasion. Nature. 2021 Nov;599:114-119.
15. Lopez Bernal J, Andrews N, Gower C, et al.Vaccines against the B.1.617.2 (Delta) Variant. N Engl J Med. 2021 Aug 12;385:585-594.
16. Dhawan M, Sharma A, Priyanka, et al. Delta variant (B.1.617.2) of SARS-CoV-2: Mutations, impact, challenges and possible solutions. Hum Vaccin Immunother. 2022 Nov 30;18: 2068883.
17. Lauring AS, Tenforde MW, Chappell JD, et al Clinical severity of, and effectiveness of mRNA vaccines against, covid-19 from omicron, delta, and alpha SARS-CoV-2 variants in the United States: prospective observational study. BMJ. 2022 Mar 9;376:e069761..
18. Nasreen S, Chung H, He S., et al. Effectiveness of COVID-19 vaccines against symptomatic SARS-CoV-2 infection and severe outcomes with variants of concern in Ontario. Nat Microbiol. 2022 Mar;7:379-385.

19. Lord JM. The effect of ageing of the immune system on vaccination responses. Hum Vaccin Immunother. 2013 Jun;9:1364-1367.
20. Collier DA, Ferreira IATM, Kotagiri P, et al. Age-related immune response heterogeneity to SARS-CoV-2 vaccine BNT162b2. Nature. 2021 Aug;596: 417-422.
21. Raszeja-Wyszomirska J, Janik MK, Wójcicki M, Milkiewicz P. SARS-CoV-2 vaccination in liver transplant recipients: factors affecting immune response and refusal to vaccine. Pol Arch Intern Med. 2022; 132: 16274.
22. Tylicki L, Biedunkiewicz B, Dąbrowska M, et al. Humoral response to SARS-CoV-2 vaccination promises to improve the catastrophic prognosis of hemodialysis patients as a result of COVID-19: the COViNEPH Project. Pol Arch Intern Med. 2021; 131: 797-801.

Table 1. Summary of vaccination status and effectiveness stratified by age category.

Age category	Population	Unvaccinated	Fully vaccinated	Fully vaccinated with BNT162b2	Mortality among not vaccinated, number (rate per 100 000)	Mortality among fully vaccinated with BNT162b2 number (rate per 100 000)	P value	Overall effectiveness of full vaccination	Number of death which could have been prevented by vaccination
5-9	1,910,470	1,632,724	28,400 (1.49%)	28,394 (1.49%)	16 (0.98)	0 (0.0)	-	100%	16
10-17	3,140,933	1,847,205	1,017,539 (32.40%)	1,014,494 (32.30%)	9 (0.49)	0 (0.0)	-	100%	9
18-24	2,688,690	1,143,376	1,475,454 (54.88%)	924,805 (34.40%)	42 (3.67)	3 (0.32)	<0.001	91.17%	38

25-49	14,216,985	5,724,338	8,227,364 (57.87%)	5,042,304 (35.47%)	2,482 (43.36)	82 (1.63)	<0.001	96.25%	2,389
50-59	4,605,466	1,457,323	3,086,998 (67.03%)	2,061,854 (44.77%)	3,850 (264.18)	189 (9.16)	<0.001	96.53%	3,716
60-69	5,185,843	1,302,817	3,833,968 (73.93%)	2,234,215 (43.08%)	13,530 (1038.52)	680 (30.43)	<0.001	97.07%	13,133
70-79	2, 930,420	541,237	2,383,313 (81.33%)	2,113,597 (72.13%)	18,869 (3486.27)	2,122 (100.40)	<0.001	97.12%	18,326
≥80	1, 683,970	571,528	1,098,696 (65.24%)	1,021,843 (60.68%)	26,014 (4551.66)	3,243 (317.37)	<0.001	93.03%	24,200
TOTAL	**36,362,777**	**14,220,548**	**21,151,732 (58.17%)**	**14,441,506 (39.71%)**	**64,812 (455.76)**	**6,319 (43.76)**	**<0.001**	**90.40%**	**61,803**

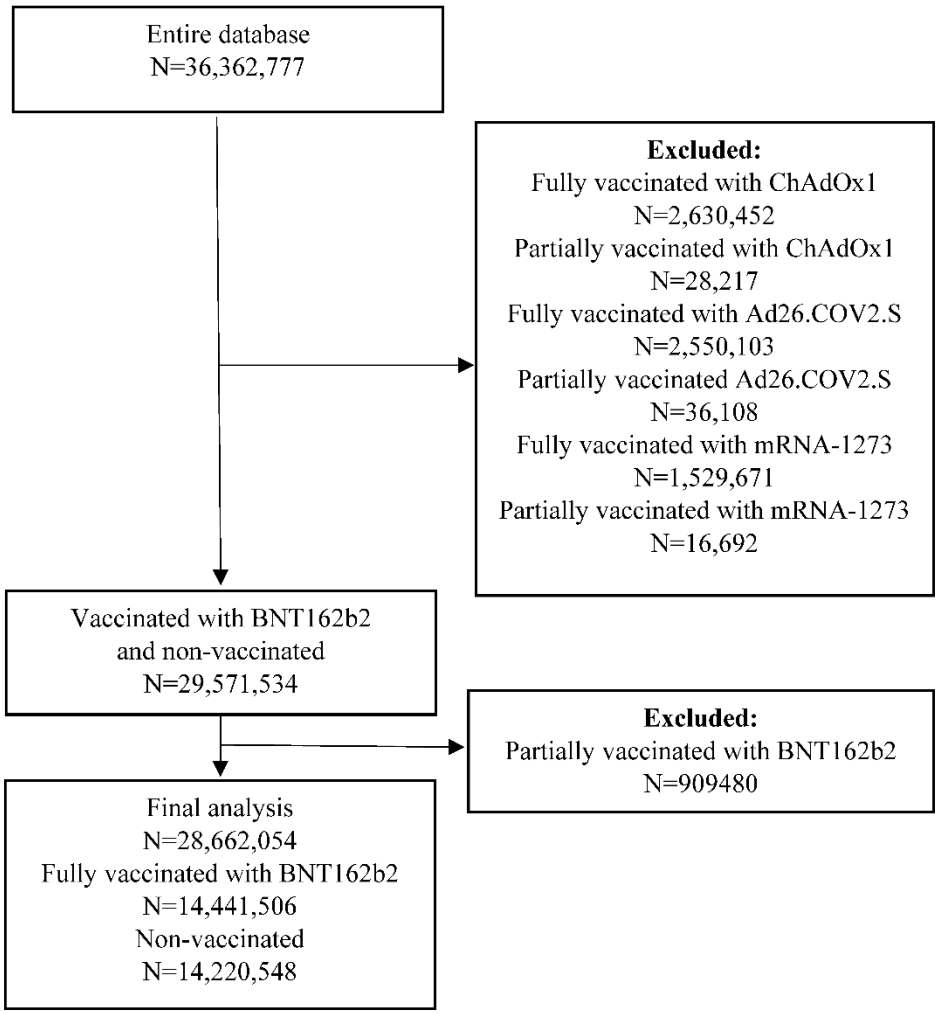

Figure 1. Study flow-chart.

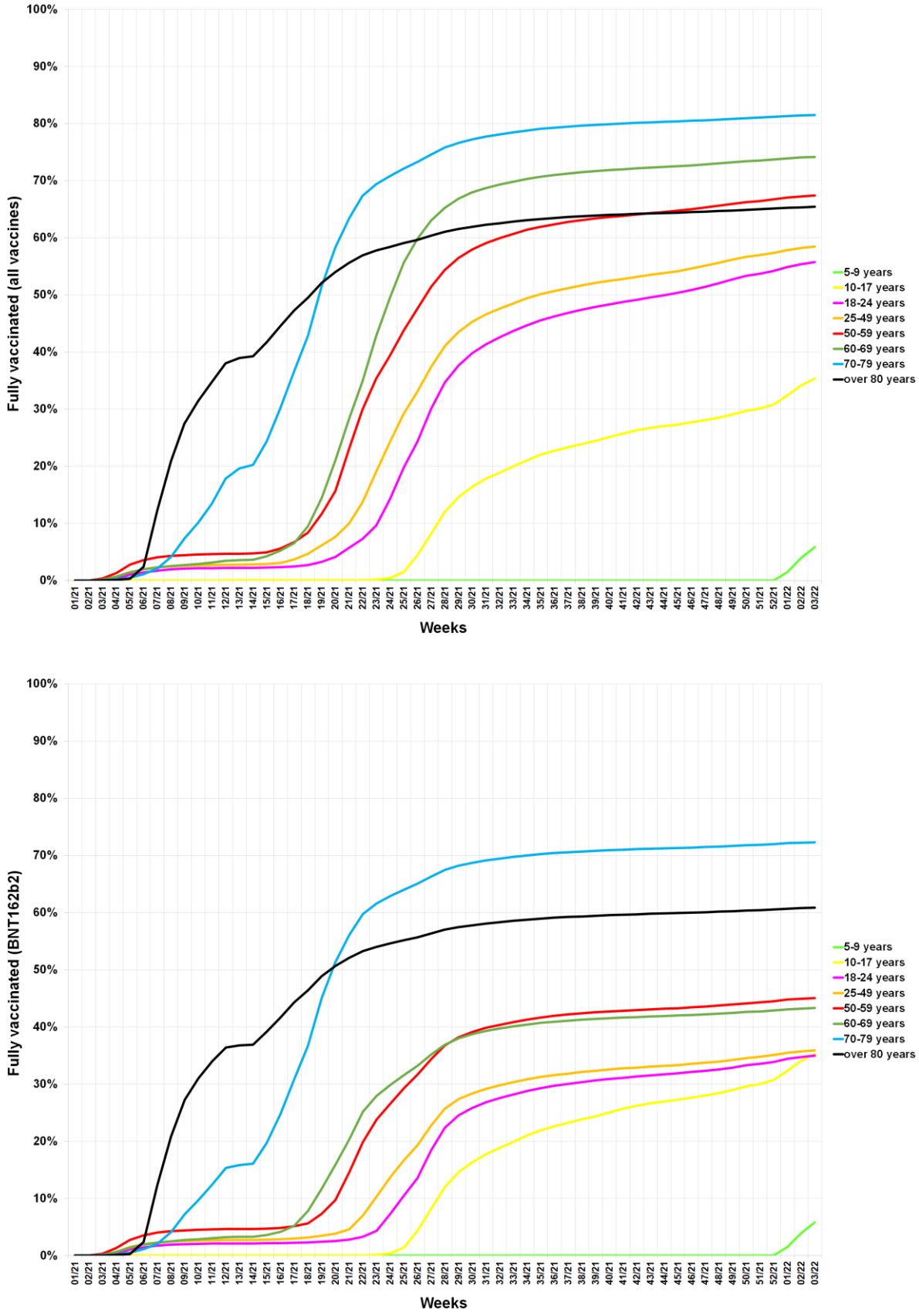

Figure 2. Vaccination status with **(A) all vaccines** and **(B) BNT162b2 vaccine** across the study period.

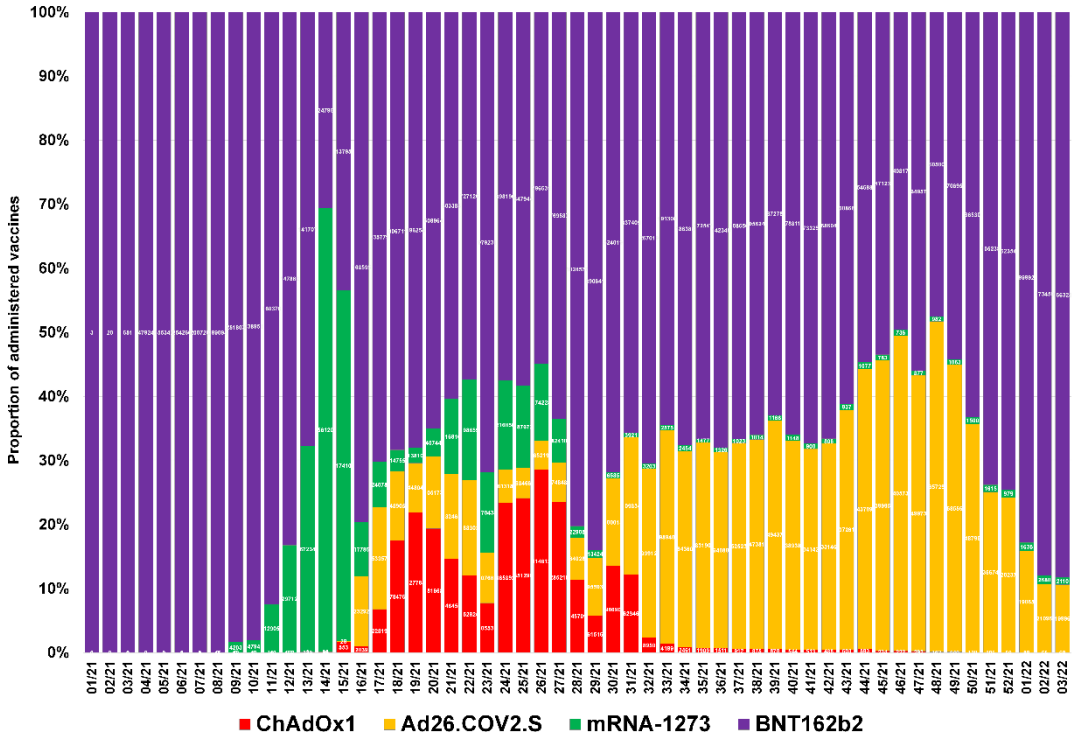

Figure 3. Proportion of vaccines administered across the study period.

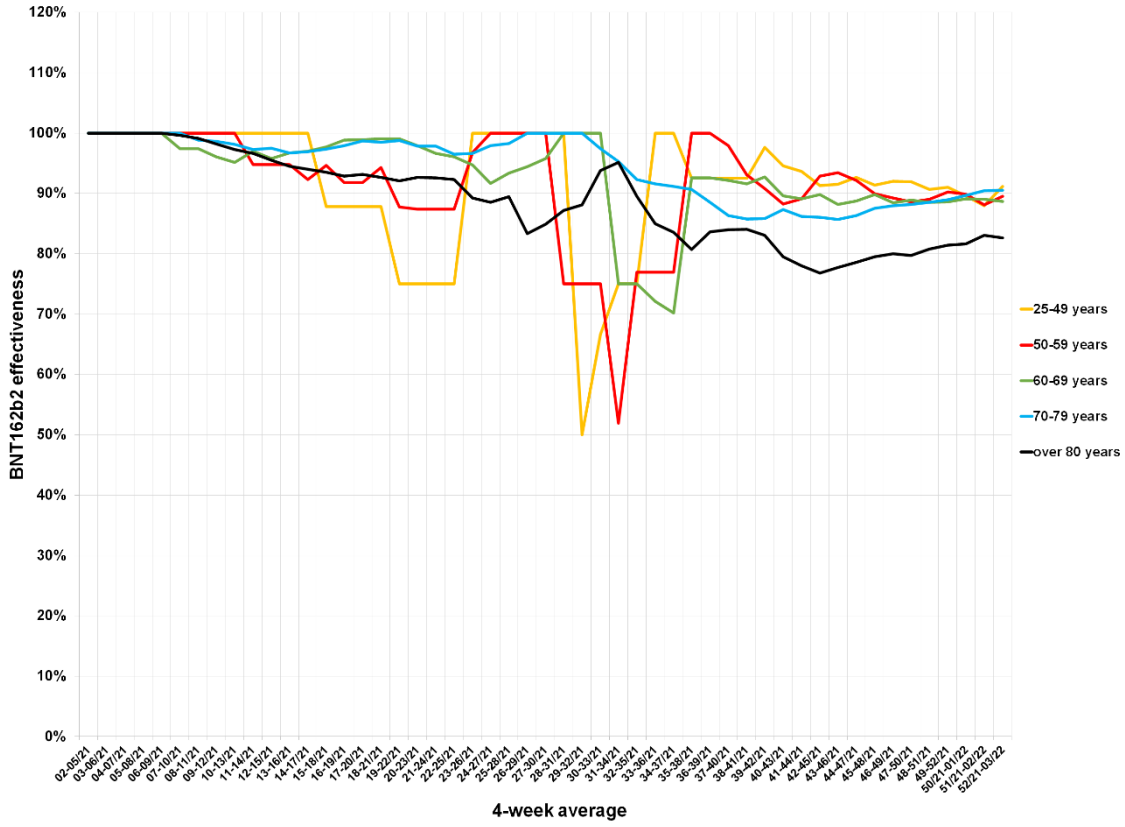

Figure 4. The effectiveness of the BNT162b2 vaccine in study groups aged from 25 to over 80 years old during week 2 of 2021 to week 3 of 2022.

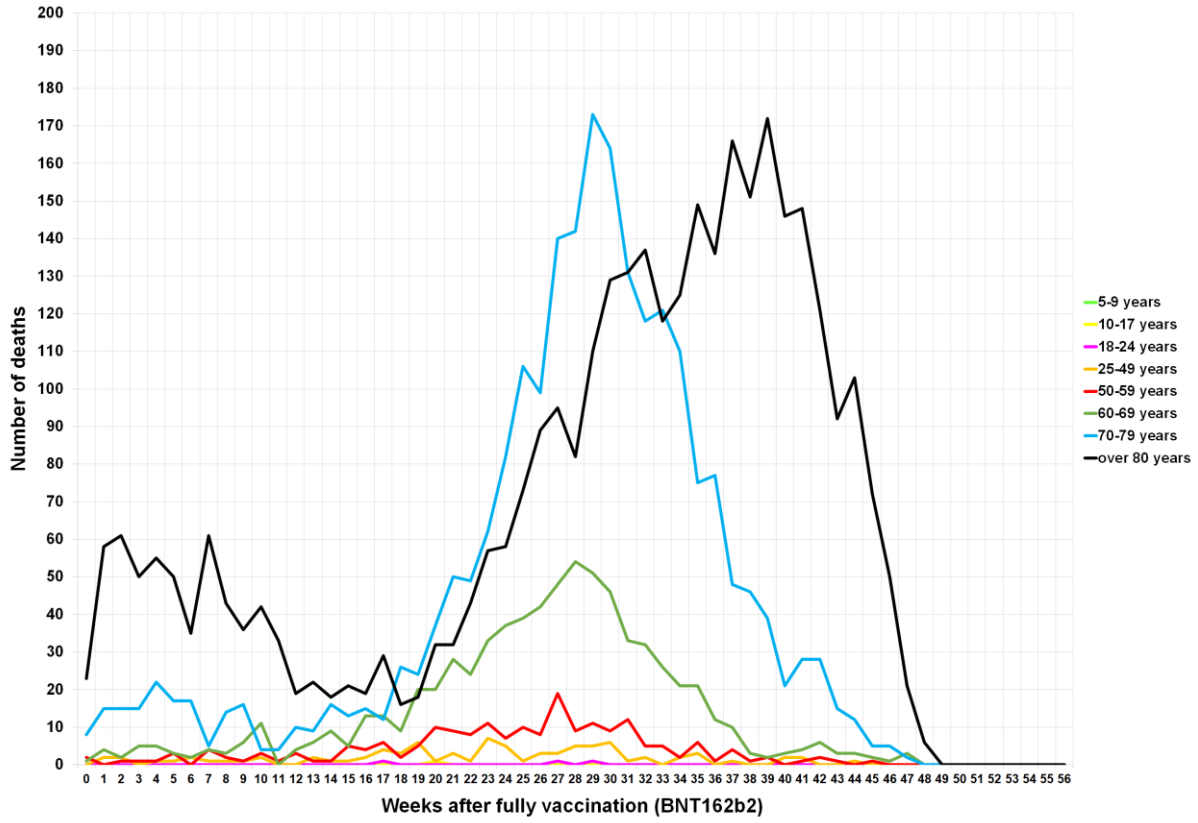

Figure 5. Number of COVID-19 deaths in patients vaccinated with BNT162b2 aged from 5 to over 80 years old during week 53 of 2020 to week 3 of 2022 including number of weeks after full vaccination.

Short title: BNT162b2 vaccine in preventing COVID-19 deaths in Poland