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Impact of Immunization in the Reduction of Mortality and Lethality Rates by COVID-19 in Brazil

Santos, Pedro Henrique Carvalho
Student, Department of Physiotherapy, Unirg Gurupi University, Brazil
Cruz, Ytalo Gustavo Silva
Student, Department of Physiotherapy, Unirg Gurupi University, Brazil
Reis, Geovane Rossone
Professor, Department of Physiotherapy, Unirg Gurupi University, Brazil
Pereira, Hiago Aparecido Soares
Student, Department of Physiotherapy, Unirg Gurupi University, Brazil
Ribeiro, Mônica Cristina Siriano
Student, Department of Physiotherapy, Unirg Gurupi University, Brazil
Siriano, Letícia Sampaio
Student, Department of Physiotherapy, Unirg Gurupi University, Brazil

Abstract:
In January 2020, a new coronavirus genetic material, Sars-CoV-2, was developed sequentially, allowing several studies to be released worldwide in search of a vaccine. In March of that year, the first vaccine was introduced and entered the human testing phase. In this scenario, this project aims to perform a correlational and comparative analysis between the immunized population of the federation units and the federal district with mortality and lethality rates by COVID-19 through statistical data treatment. The study was conducted in a statistical, retrospective study, with data available in sites linked to the Ministry of Health and the state health departments. In addition, for statistical treatment, the correlation of the data found and linear regression will be performed. Thus, all data will be gathered through data from DATASUS and the sites of each unit of the federation, covering the entire immunization period in which the country is being submitted. After data collection, they will be grouped and tabled using excel for Windows® and Word for Windows® software tools for making charts and tables. State data related to the number of immunized individuals will be compared by the students' T-test and compared using the SPSS® software. Based on the data collected, it is expected to have an overview of the impact of immunization on the reduction of COVID-19 mortality rates in all states of the country.

Keywords: *Immunization, COVID-19, lethality*

1. Introduction

In January 2020, a new coronavirus genetic material, Sars-CoV-2, was developed sequentially, which allowed several studies to be released worldwide in search of a vaccine. In March of that year, the first vaccine was introduced and entered the human testing phase.

By the end of August 2020, more than a dozen experimental vaccines had been tested on humans in Brazil. One year after the discovery of the virus in December 2020, the Vaccine against SARS-CoV-2 was launched in several countries around the world and was launched on January 17, 2021, in Brazil (BEE et al., 2022).

The goal of the COVID-19 vaccination campaign is to save lives and reduce the risk of infection and the occurrence of serious cases. Till now, there are four vaccines available in the country: Coronavac, AstraZeneca, Janssen, and Pfizer, which have different efficacy and schedule of vaccines (the period between the first and second dose). Its efficacy for the variants prevalent in Brazil has been shown mainly in reducing mortality and hospitalization beyond the average length of hospitalization (DE OLIVEIRA et al., 2022).

In this follow-up, São Paulo was the first state to launch an immunization campaign against COVID-19 on January 17, 2021, and is also the first state to reach 92.72% of the full adult calendar. Despite the advance of the vaccine in Brazil, only three southern states have more than 80% of this fully vaccinated population: Paraná (81.97%), Rio Grande do Sul (81.42%), and Santa Catarina (80.28%). Even in this scenario, in almost all states, 90% of adults have at least a first dose of the vaccine, except for Roraima (75.43%), Amapá (82.47%), Maranhão (88.09%) and Rondônia (89.39%) (DA SILVA et al., 2022).

Among the regions that presented alarming indices in relation to mortality, the Northern Region presented the highest numbers, with an increase in incidence and mortality from the 15th week.

Therefore, this project aims to perform a correlational and comparative analysis between the immunized population of the federation units and the federal district with mortality and lethality rates by COVID-19 through a statistical treatment of data.

2. Theoretical Reference

On February 3, 2020, Brazil declared a Public Health Emergency of National Importance (ESPIN) (BRASIL, 2020). On February 26, 2020, the first case of COVID-19 was confirmed. On March 3, there were 488 reported suspected cases, 2 confirmed and 240 discarded in the country, with no evidence of local transmission. The first two confirmed cases were of male individuals living in the city of São Paulo who had returned from travel to Italy.

To better understand the landscape of the disease in the country, the term 'mortality rate' is widely used. It serves to analyze the impact of a disease or condition on the entire population of a region and is calculated in relation to the number of people who die from a specific disease by the total number of people in the region under study.

Another important factor to consider is the lethality rate, which assesses the number of deaths related to people who have the active disease and not the entire population. It evaluates the percentage of infected people who progress to death. The COVID-19 lethality rate calculated in Brazil in April 2022 indicates a percentage of 2.2%, while in Peru and Bulgaria, we can find lethality rates of 6% and 3.2%, respectively.

The profile of the number of deaths in Brazil by the date of notification of the disease can be observed in figure 1.

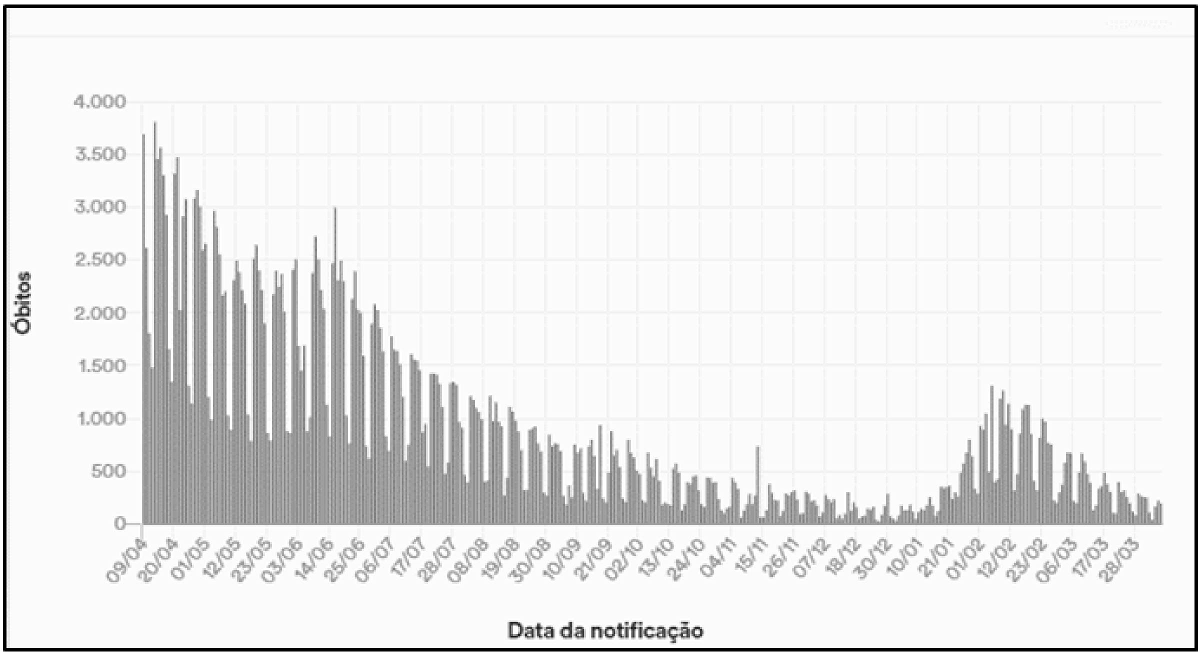

Figure 1: The Number of Deaths in Brazil by Date of Notification of the Disease
Source: State Health Departments. Brazil (2021-2022)

In the hope of developing safe and effective vaccines, non-pharmacological measures have been established worldwide to contain the virus's circulation, reducing its transmission. Among these non-pharmacological measures are:

- The use of masks,
- Social distancing,
- Hand hygiene,
- Ventilation of environments,
- Wide testing for COVID-19,
- Lockdowns, and
- Border closures (WHO, 2020)

In 2021, with the arrival of vaccines, the health crisis scenario still remained due to the lack of federal political support for this pharmaceutical measure, which promoted the nationwide disorganization of the vaccination strategy in the country (DOMINGUES, 2021).

According to data from a consortium of press vehicles available on the G1 portal, only in 2022 did vaccination in Brazil reach 75.23% of vaccinated with two doses or a single dose and only 37.19% vaccinated with the booster dose. Table 1 shows the current panorama of vaccination in Brazilian states.

State	2nd Dose Or Single Dose (Units)	2nd Dose Or Single Dose (In %)	Booster Dose (Units)	Booster Dose (In %)	1st Dose (Unit)	1st Dose (In %)	Total Vaccines Applied
Acre	517.551	56,31%	153.128	16,66%	629.432	68,48%	1.134.453
Alagoas	2.158.877	63,90%	885.778	26,22%	2.517.616	74,52%	4.620.806
Amazonas	2.588.215	59,75%	1.060.494	24,48%	3.099.709	71,56%	5.627.144
Amapá	425.135	47,59%	107.388	12,02%	546.344	61,16%	954.277
Bahia	10.798.406	71,81%	4.971.736	33,06%	11.450.428	76,15%	21.984.456
Ceará	7.329.369	78,87%	3.835.819	41,28%	7.924.992	85,28%	15.077.774
Distrito Federal	2.351.114	75,12%	1.126.077	35,98%	2.498.325	79,82%	4.790.162
Espírito Santo	3.152.567	75,93%	1.514.311	36,47%	3.459.155	83,31%	6.502.703
Goiás	4.955.900	67,89%	1.882.544	25,79%	5.686.868	77,90%	10.642.768
Maranhão	4.177.318	58,09%	1.406.177	19,55%	5.368.964	74,66%	9.426.169
Minas Gerais	16.518.208	76,74%	8.967.947	41,66%	17.500.230	81,30%	33.500.332
Mato Grosso do Sul	2.155.390	75,15%	1.068.657	37,26%	2.224.214	77,55%	4.122.159
Mato Grosso	2.369.687	65,69%	805.519	22,33%	2.730.321	75,69%	5.005.870
Pará	6.420.561	72,45%	1.303.907	14,71%	6.832.234	77,10%	13.252.795
Paraíba	3.209.277	64,44%	1.729.290	42,39%	3.458.025	76,71%	6.582.526
Pernambuco	7.033.010	72,27%	3.200.070	32,88%	8.123.792	83,48%	14.983.676
Piauí	2.713.353	82,33%	1.332.208	40,42%	3.048.915	92,51%	5.707.998
Paraná	9.075.607	77,73%	4.521.940	38,73%	9.796.728	83,91%	18.541.412
Rio de Janeiro	12.558.725	71,53%	5.607.531	31,94%	13.938.188	79,39%	26.112.455
Rio Grande do Norte	2.622.441	73,11%	1.443.623	40,25%	2.882.038	80,35%	5.441.678
Rondônia	1.094.556	59,69%	364.454	19,88%	1.279.627	69,79%	2.374.183
Roraima	319.259	47,63%	76.470	11,41%	414.107	61,78%	722.329
Rio Grande do Sul	8.894.716	77,29%	4.705.515	40,89%	9.610.758	83,51%	18.188.356
Santa Catarina	5.656.833	76,21%	2.382.332	32,10%	6.115.618	82,39%	11.523.270
Sergipe	1.749.754	74,21%	869.767	36,89%	1.954.264	82,88%	3.663.893
São Paulo	39.808.203	84,70%	24.255.969	51,61%	41.944.549	89,25%	80.517.436
Tocantins	972.052	59,85%	317.558	19,55%	1.132.839	69,75%	2.056.766

Table 1: Vaccination Campaign by State
Source: (G1, 2022)

At the beginning of 2022, 104 vaccines were being developed worldwide, 8 of which were approved by the World Health Organization (WHO, 2020) (Knoll et al., 2020) and 4 by the Brazilian National Health Surveillance Agency (ANVISA, 2021).
They are:

2.1. Oxford/Astra Zeneca

The ChAdOx nCoV-19 vaccine, better known as AstraZeneca (Oxford-AstraZeneca), is produced using the viral vector model. It is composed of a single recombinant chimpanzee adenovirus vector, deficient for replication, which expresses coronavirus glycoprotein S.

2.2. Janssen

The Vaccine Ad26.COV2.S, from the pharmaceutical company Johnson & Johnson, known as Janssen, is produced using a recombinant adenovirus vector and was derived from the first clinical isolate of the Wuhan strain in China (SADOFF et al., 2021). The vaccine uses the technique of introduction of a recombinant adenovirus.

2.3.CoronaVac

CoronaVac is a vaccine that works with inactivated viruses, that is, dead. In immunizers of this type, the virus reaches this state with the use of chemical substances (those used in CoronaVac are formaldehyde – which prevents the growth of microorganisms in various products – and beta-propiolactone).

2.4.Pfizer

Produced by the U.S. laboratory Pfizer, in partnership with the German laboratory BioNTech, the Pfizer-BioNTech COVID-19 vaccine (BNT162b2) is a formulated lipid nanoparticle of nucleoside modified mRNA encoding the pre-fusion peak glycoprotein of SARS-CoV-2, which cause COVID-19 disease (OLIVER et al., 2020).

3. Materials and Methods

This project is a statistical, retrospective study, with data available in sites linked to the Ministry of Health and the state health departments, of quantitative nature of analysis and correction of data.

Data made available are incomplete or in any way may lead to any systematic error due to a lack of information.

This study offers minimal risks, as researchers will not have direct contact with humans or make any interventions. They will have risks only related to the exposure of data. However, all efforts to maintain confidentiality about possible individual data will be carried out by those surveyed.

Since it is a statistical study of conclusive objective, data related to the efficacy of immunization of vaccines precoimente developed may generate concrete data that can integrate reports of analytical results. Furthermore, it will be possible to make an in-depth analysis of public health policies and correlate them with the results of early immunization.

Initially, data will be collected that will be the interstice of 12 months of vaccine, where they will be gathered through the website of DATASUS, a portal of the consortium of press vehicles, and through the websites of the Health Secretariats of each unit of the federation, as shown in table 2. The data will be collected from the first day of the second month of the beginning of the vaccination schedule in the country, which began in January 2021, which means the data collected will start from February 1, 2021, to January 31, 2022. After data collection, they will be grouped (APPENDIX) and tabled using Excel for Windows® and Word for Windows® tools for making description charts.

Description	Site
G1	https://especiais.g1.globo.com/bemestar/vacina/2021/mapa-brasil-vacina-covid/
Datasus	https://opendatasus.saude.gov.br/dataset/covid-19-vacinacao
Conselho Nacional De Saúde	https://conselho.saude.gov.br/vacinometro
Acre	http://covid19.ac.gov.br/monitoramento/notificacoes/esus
Amazonas	https://www.fvs.am.gov.br/indicadorSalaSituacao_view/75/2
Roraima	https://www.saude.rr.gov.br/component/sppagebuilder/?view=page&id=44
Pará	http://www.saude.pa.gov.br/rede-sespa/cievs/vacinometro/
Amapá	http://painel.corona.ap.gov.br/vacina/
Maranhão	https://painel-covid19.saude.ma.gov.br/vacinas
Piauí	http://coronavirus.pi.gov.br/
Ceará	https://www.saude.ce.gov.br/vacinometro/
Rio Grande do Norte	https://rnmaisvacina.lais.ufrn.br/cidadao/covid/
Paraíba	https://paraiba.pb.gov.br/diretas/saude/coronavirus/painel-de-vacinacao
Pernambuco	https://conectarecife.recife.pe.gov.br/vacinometro/
Alagoas	https://vacina.maceio.al.gov.br/
Sergipe	https://todoscontraocorona.net.br/
Rondônia	https://covid19.sesau.ro.gov.br/Home/Vacina?IdCidade=Porto+Velho&DataTables_Table_0_length=10
Mato Grosso	https://vacina.cuiaba.mt.gov.br/
Tocantins	http://integra.saude.to.gov.br/covid19/Vacinometro
Baía	https://bi.saude.ba.gov.br/vacinacao/
Mato Grosso do Sul	https://www.saude.ms.gov.br/e-vacine/
Goiás	https://indicadores.saude.go.gov.br/pentaho/api/repos/:coronavirus:paineis:painel.wcdf/generatedContent
Distrito Federal	https://www.saude.df.gov.br/
Minas Gerais	https://coronavirus.saude.mg.gov.br/vacinometro
Espírito Santo	https://coronavirus.es.gov.br/
Rio de Janeiro	https://vacinacaocovid19.saude.rj.gov.br/vacinometro
São Paulo	https://www.saopaulo.sp.gov.br/
Paraná	http://bi.pr.gov.br/COVID/index.html
Santa Catarina	http://www.coronavirus.sc.gov.br/
Rio Grande do Sul	https://vacina.saude.rs.gov.br/

Table 2: Data Collection and Analysis Sites
Source: Authors, 2022

After data collection and grouping in the instrument, the states will be ranked in a decreasing manner according to the percentage of the immunized population. The data will be submitted for validation by the students' T-test through the SPSS® software. With the data already validated, they will be compared in a simple way, where the mortality/infected relationship will be performed to find the lethality of the disease in each Federation Unit. With the grouped data, a treatment will be made with Pearson's correlation to verify positive or negative results for immunization. Based on the results of the Person correlation, the mortality rates analyzed will undergo a statistical regression to evaluate the relationship of the variables.

The values will be demonstrated through tables and graphs, considering the significance level of $p<0.05$ or 5% through SPSS®.

4. Results and Discussions

A table assembled in Microsoft Excel was used®, in which the percentage of mortality rates matched the immunized population of each state was performed.

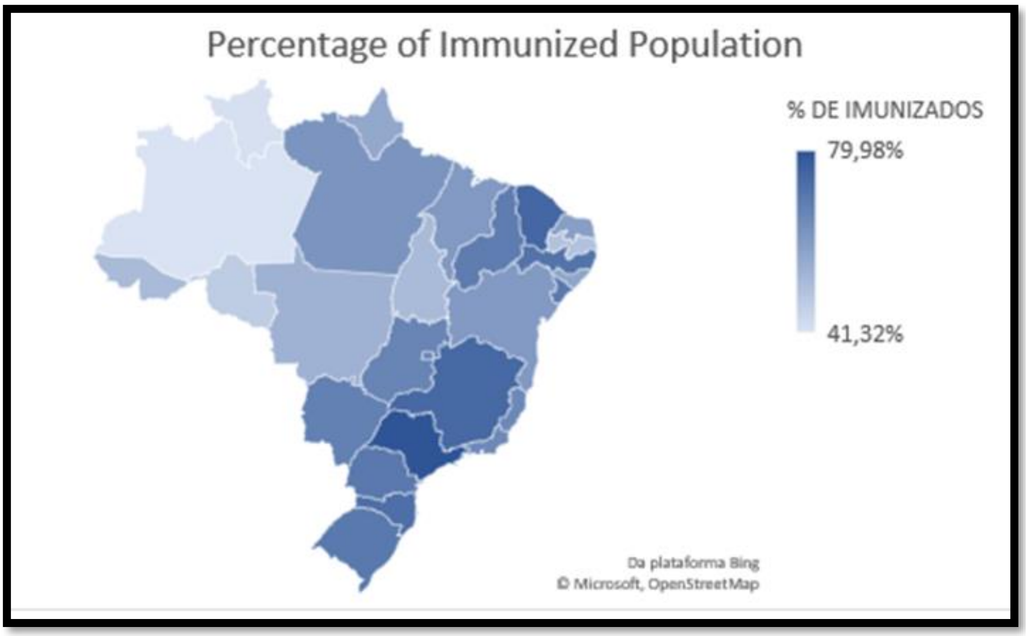

Figure 2: Percentage of the Immunized Population

In the graph above, the percentage of the immunized population was measured, and they were instructed to take at least two doses or a single dose.

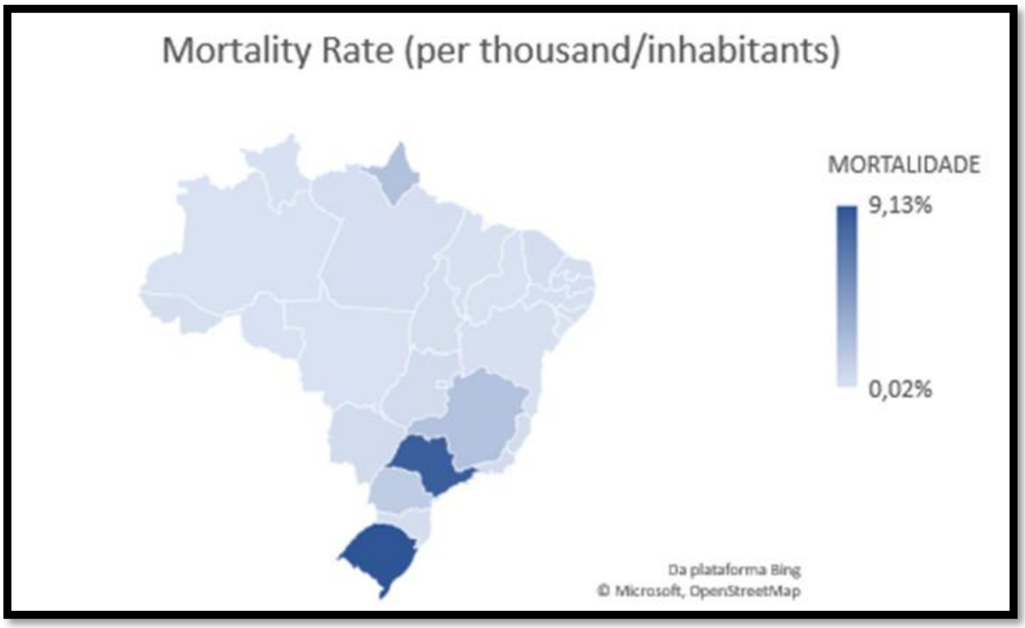

Figure 3: Mortality Rate

In this graph, the percentage of the population that was contaminated by COVID-19 was measured.

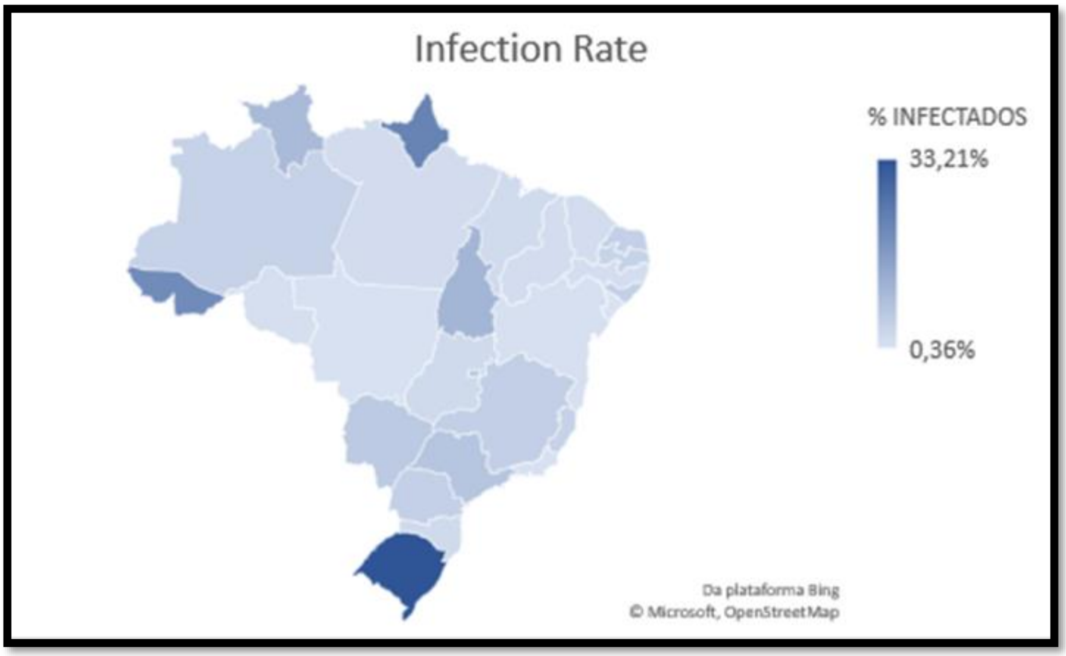

Figure 4: Infection Rate

In this graph, the percentage of the population that was contaminated by COVID-19 was measured.

Coefficient from Pearson	Immunization Partial	Immunization Complete	Infection Rate	Mortality Rate
Immunization Partial	1	0,613	-0,106	0,381
Immunization Complete	0,613	1	-0,242	0,287
Infection Rate	-0,106	-0,242	1	0,609
Mortality Rate	0,381	0,287	0,609	1

Table 3: Coefficient from Pearson

In this data, there was a negative correlation; the higher the number of immunized, the lower the infection rate. If the positive correlation is above 0, the higher the infected rate, the higher the mortality rate. States that had complete immunization had a higher mortality rate, thus being positive, but the correlation should be negative; containing complete immunization, the mortality rate should be lower. In the negative data, the higher the number of immunized, the lower the infection rate.

5. References

i. BEE, Grega Rúbia et al. Vacinas contra COVID-19 disponíveis no Brasil. Brazilian Journal of Development, v. 8, n. 1, p. 6246-6263, 2022.

ii. DA SILVA, Danilo Francisco Marçal et al. MORTALIDADE POR COVID-19 E VACINAÇÃO EM IDOSOS: UM ESTUDO ECOLÓGICO NA CIDADE DE CURITIBA, PARANÁ, BRASIL. The Brazilian Journal of Infectious Diseases, v. 26, p. 102039, 2022.

iii. DE OLIVEIRA, Rita de Cássia Silva et al. Desenvolvimento de vacinas contra a COVID-19: uma revisão de literatura. Brazilian Journal of Health Review, v. 5, n. 1, p. 3473-3492, 2022.

iv. DE SÁ, Alexander Vilela Filho et al. Vacinas para Covid-19: Uma revisão de literatura. Brazilian Journal of Development, v. 8, n. 1, p. 1880-1901, 2022.

v. FERREIRA, Vinícius Moura et al. Avaliação epidemiológica das regiões do Brasil na pandemia de COVID-19. Revista Eletrônica Acervo Saúde, v. 13, n. 4, p. e7137-e7137, 2021.

vi. MA, Jianfang, et al. Spatial Patterns of the Spread of COVID-19 in Singapore and the Influencing Factors. ISPRS International Journal of Geo-Information, v. 11, n. 3, p. 152, 2022.

vii. ALVES, Polyana Silva et al. Vacinas: história, tecnologia e desafios para terapia contra o SARS-CoV-2. Ulakes Journal of Medicine, v. 1, 2020.

viii. Agência Nacional de Vigilância Sanitária. Nota da Anvisa: Anvisa concede primeiro registro definitivo para vacina contra a Covid-19 nas Américas. Agência Nacional de Vigilância Sanitária, 2021. Disponível em: <https://www.gov.br/pt-br/noticias/saude-e-vigilancia-sanitaria/2021/02/anvisa-concede-primeiro-registro-definitivo-para-vacina-contra-a-covid-19-nas-americas>.

ix. Banerji, A. et al. Vacinas de mRNA para prevenir a doença COVID-19 e reações alérgicas relatadas: evidências atuais e abordagem sugerida. O jornal de alergia e imunologia clínica. Na prática , 9 (4), 1423–1437. 2021.

https://doi.org/10.1016/j.jaip.2020.12.047
x. BEE, Grega Rúbia et al. Vacinas contra COVID-19 disponíveis no Brasil. Brazilian
xi. Journal of Development, v. 8, n. 1, p. 6246-6263, 2022.
xii. BRASIL. Ministério da Saúde. Portaria MS/GM nº 188, de 3 de fevereiro de 2020. Declara Emergência em Saúde Pública de importância Nacional (ESPIN) em decorrência da Infecção Humana pelo novo Coronavírus (2019-nCoV) [Internet]. Diário Oficial da União, Brasília (DF), 2020 fev 4; Seção Extra:1. Disponível em: <http://www.in.gov.br/web/dou/-/portaria-n-188-de-3-de-fevereiro-de-2020-241408388>
xiii. DA SILVA, Danilo Francisco Marçal et al. MORTALIDADE POR COVID-19 E VACINAÇÃO EM IDOSOS: UM ESTUDO ECOLÓGICO NA CIDADE DE CURITIBA, PARANÁ, BRASIL. The Brazilian Journal of Infectious Diseases, v. 26, p. 102039, 2022.
xiv. DE OLIVEIRA, Rita de Cássia Silva et al. Desenvolvimento de vacinas contra a COVID-19: uma revisão de literatura. Brazilian Journal of Health Review, v. 5, n. 1, p. 3473-3492, 2022.
xv. DE SÁ, Alexander Vilela Filho et al. Vacinas para COVID-19: Uma revisão de literatura. Brazilian Journal of Development, v. 8, n. 1, p. 1880-1901, 2022.
xvi. DOMINGUES, CMAS. Desafios para a realização da campanha de vacinação contra a COVID-19 no Brasil. Cad Saude Publica. 2021; 37(1):e00344620.
xvii. FREIRE, M. G. Vacina de Oxford: passaporte para a vida em liberdade? Boletim de Pesquisa e Desenvolvimento DO ISECENSA, V. 3, N. 7. 2020.
xviii. G1. Mapa da vacinação contra COVID-19 no Brasil. 2022. Disponível em: <https://especiais.g1.globo.com/bemestar/vacina/2021/mapa-brasil-vacina-covid/> Access: 07/04/2022.
xix. Johns Hopkins Coronavirus Resource Center (CRC). Mortality Analysis. Bloomberg Philanthropies and the Stavros Niarchos Foundation. Disponível em: <https://coronavirus.jhu.edu/about>
xx. Knoll M D, Wonodi C. Oxford–AstraZeneca COVID-19 vaccine efficacy. Elsevier. 2020. Disponível em: <https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)32623-4/fulltext>.
xxi. Ministério da Saúde. Secretaria de Vigilância em Saúde (SVS): Guia de Vigilância Epidemiológica do COVID-19. Secretarias Municipais e Estaduais de Saúde. Disponível em: <https://covid.saude.gov.br/>
xxii. MA, Jianfang, et al. Spatial Patterns of the Spread of COVID-19 in Singapore and the Influencing Factors. ISPRS International Journal of Geo-Information, v. 11, n. 3, p. 152, 2022.
xxiii. Oliver S, Gargano J, Marin M, et al. The Advisory Committee on Immunization Practices' Interim Recommendation for the use of Pfizer-BioNTech COVID-19 Vaccine — United States. MMWR Morb Mortal Wkly Rep 2020;69:1922-1924. 2020. DOI: http://dx.doi.org/10.15585/mmwr.mm6950e2
xxiv. Organização pan-americana de saúde (OPAS) Disponível em: https://www.paho.org/pt/topics. Ministério da saúde. 2021.
xxv. Sadoff J, Le Gars M, Shukarev G, et al. Interim results of a phase 1–2a trial of Ad26. COV2. S COVID-19 vaccine. N Engl J Med. 2021;384(19):1824–1835.
xxvi. Tribunal de contas da união (TCU). 2021. Disponível em: <https://portal.tcu.gov.br/inicio/>.
xxvii. World Health Organization (WHO). WHO Director General's Opening Remarks at the Media Briefing on COVID-19 [Internet]. 2020 March 11. Disponível em: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>.
xxviii. World Health Organization (WHO). Coronavirus disease (COVID-19) advice for the public. [Internet]. 2021. Disponível em: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public>.