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The impact of geo-political socio-economic factors on vaccine dissemination trends: a case-study on COVID-19 vaccination strategies

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Abstract

Background The world in recent years has seen a pandemic of global scale. To counter the widespread loss of life and severe repercussions, researchers developed vaccinations at a fast pace to immunize the population. While the vaccines were developed and tested through extensive human trials, historically vaccines have been known to evoke mixed sentiments among the generic demographics. In the proposed study, we aim to reveal the impact of political and socio-economic factors on SARS-Cov-2 vaccination trends observed in two hundred and seventeen countries spread across the six continents.

Methods The study had hypothesized that the citizens who have lower trust in their government would be less inclined towards vaccination programs. To test this hypothesis, vaccination trends of nations under authoritarian rule were compared against democratic nations. Further, the study was synthesized with Cov-2 vaccination data which was sourced from Our World Data repository, which was sampled among 217 countries spread across the 6 continents. The study was analyzed with exploratory data analysis and proposed with relevance and impacting factor that was considered for vaccine dissemination in comparison with the literacy rate of the nations. Another impacting factor the study focused on for the vaccination dissemination trends was the health expenses of different nations. The study has been synthesized on political and socio-economic factors where the features were ardently study in retrospect of varied socio- economic features which may include country wise literacy rate, overall GDP rate, further we substantiated the work to address the political factors which are discussed as the country status of democratic or having other status.

Results The comparison of trends showed that dissemination of SARS-Cov-2 vaccines had been comparable between the two-opposing types of governance. The major impact factor behind the wide acceptance of the SARS-Cov-2 vaccine was the expenditure done by a country on healthcare. These nations used a large number of vaccines to administer to their population and the trends showed positive growth. The overall percentage of vaccine utilized by countries in quantitative terms are Pfizer/BioNTech (17.55%), Sputnik V (7.08%), Sinovac (6.98%), Sinopharm/Beijing (10.04%), Oxford/AstraZeneca (19.56%), CanSino (2.85%), Moderna (12.05%), Covaxin (3.28%), JohnsonandJohnson (10.89%), Sputnik Light (3.07%), Novavax (3.49%). While the nations with the lowest healthcare expenses failed to keep up with the demand and depended on vaccines donated by other countries to protect their population.

Conclusions The analysis revealed strong indicators that the nations which spend more on healthcare were the ones that had the best SARS-Cov-2 vaccination rollout. To further support decision-making in the future, countries should

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address the trust and sentiment of their citizens towards vaccination. For this, expenses need to be made to develop and promote vaccines and project them as positive health tools.

Keywords COVID-19, Vaccination, Prognosis and diagnosis, Artificial intelligence, Machine learning

Introduction

The global stance, in the current scenario of the pandemic, has imposed a substantial burden on healthcare practitioners. The ultimate aim of researchers and scientists worldwide is to fight the ongoing situation and discover significant vaccines which can reduce the mortality rate among society. As we know, the decisive way to overcome the ongoing situation is to immunize the population. Moreover, the existing circumstances infer that, if we need to prevent and control the spread of COVID-19, then immunization would play an imperative role.

Certainly, COVID-19 has imprudently created several challenges among young researchers, scientists, and healthcare practitioners around the globe [1–4]. To address the key challenges, the interdisciplinary research areas such as education, healthcare, industrial, stock market, food and beverage were examined to determine the factors i.e. socio, behavioral, economical parameters in the vaccine strategy which can directly or indirectly influence the study [2, 3]. Hence, the trial of studies was performed at varying stages which included the clinical trials, spatial parameters of the spread of disease, factors corresponding to disease patients, and others. To discuss the overall impact of studies conducted, the challenge is to disseminate the data and predict information from big databases [5, 6].

To address the vital issues of real-world data complexity, several adoptive technologies such as computer vision, Tele health was need of time and assistive technologies implemented such as visualization-based models to assist the need of the patients also several communication modules were implemented to assist with the work from home and support the overall population to best fit the current scenario [7]. Also, we can say that to curb the spread of COVID 19, Machine learning (ML)and Artificial Intelligence (AI) are well-known techniques, which are deployed to discover hidden information from varied databases. The global network of clinicians, scientists, and healthcare practitioners are trying to accelerate the research programs while utilizing AI and ML to develop an effective and efficient COVID -19 vaccine that can benefit the human population among all age groups [8, 9]. Usually, ML and AI are evolved to develop a prediction-based tool or decision making, which can outline the future adverts of healthcare outcomes [10].

We can say that the healthcare organizations are explicitly searching for appropriate technology which can track the epidemiological synchronization or cofactors which can relate to pandemic spread [9, 10]. However, cofactors can easily studied with AI and ML which can set vulnerable benefits of diagnosis while measuring the effectiveness of the drug, spread of COVID 19, and detecting the co-vital features associated with the disease [11–13]. Further, we can say that AI and ML-based technology are the decision-making platforms which can assist healthcare practitioners to fight the battle of COVID -19 while giving a recommendation, medical features extractions, patient-assisted control, and other services which we can think of.

Further, the utilization of ML and AI has flourished their advances in the pandemic era, victoriously in several application domains which include military organizations, healthcare, business analytics, and other technological intervention while gaining momentum and success stories [11–13]. For example, the chest CT scan images were applied with medical imaging analysis using ML and AI-based algorithms to detect the prognosis of the disease in a short period, as well as citing the drug discovery module which can benefit the patient [14, 15]. In addition, ML and AI-based studies were applied to study the societal and behavioral implications of patients and develop intelligent models which can benefit the post-Covid era of patients [16]. Moreover, several human transmission models were also generated to identify and predict the outbreak of disease and other severities aligned with spread [16, 17].

Further, considering the relative global impact of vaccination with vital features such as literacy rate, disabilities, older generation and many other factors in retrospect of the citizens and certain formulation suggested that users those have lower trust in their government were less inclined towards vaccination programs [17]. In accordance, to the previous work we tried to determine the vaccination trends among varied nations under authoritarian rule as well as comparison was strategized against democratic nations [17, 18]. The comparison of trends showed that dissemination of the SARS-Cov-2 vaccine had been comparable between the two-opposing types of governance. Further, the study was proposed with relevance and impacting factor that was considered for vaccine dissemination in comparison with the literacy rate of the nations. The correlated factor was referred to as the country's literacy rate, which is an indicator of its economy and living standards [14]. In agreement with the above problem,

the vaccination trends were represented, with vital features of lesser literacy rates having extremely low and flat growth curves for vaccination numbers [15]. In similar, another impacting factor that the study focused on was the vaccination dissemination trends in comparison with the health expenses of different nations. The curves were strong indicators that the nations that spend more on healthcare were the ones that had the best SARS-Cov-2 vaccination rollout [16]. These nations used a large number of vaccines to administer to their population and the trends were positive growth [17]. While the nations with the lowest healthcare expenses failed to keep up with the demand and depended on vaccines donated by other countries to protect their population [18].

In the proposed study, we aim to reveal the impact of political and socio-economic factors on SARS-Cov-2 vaccination trends in different countries. The study has been synthesized on political and socio-economic factors where the features were ardently study in retrospect of varied socio- economic features which may include country wise literacy rate, overall GDP rate, further we substantiated the work to address the political factors which are discussed as the country status of democratic or having other status which are discussed elaborated in methodology section.

Literature review

Data science can be discussed as a vibrant tool for developing and supporting vaccine dissemination. The major role is to discover the protein structure which can enable the clinicians and data scientists to discover the patterns for future research repositories and identification of drug discovery. We can say that vaccine is the only possibility that can control the dissemination of COVID 19 cases around the globe [18]. However, the statistics represents that few vaccines have received permission to use, as in case of emergency conditions that can benefit the healthcare practitioners and others. In context, several vaccination programs are laid into the process to assure the wellbeing, safety, and control of the blowout of the COVID-19 [18–20]. Hence, we can say that earlier vaccine development was a trivial task, but the advent technology introduced has the ability to identify the protein structure and develop a new drug for a deeper understanding of the virus. Google with integrated technology of AI launched the Alphafold tool, which tends to be an automatic and specialized tool that can predict the new vital 3D protein structure while input as the genetic sequence [21]. The above cited approached focused on detection of the untreated proteins which regulate the SARS-COV-2 virus and generate a protein structure [17, 22].

The concept of reverse vaccinology (RV) with ML tools was utilized to forecast and develop a vaccine for COVID -19. The RV was applied to discover the pathogen using genomes. The study prevailed to discover the proteins which were responsible for the virus which includes SARS-CoV, MERS-CoV, HCoV-229E, and others where were discovered from Uniprot proteins. Moreover, they have exploited the ML techniques Vaxign-ML to detect and discover the signal behavior of the proteome of the virus, to forecast the relevance of biological signals [23]. Further, the Vaxign-ML model was formulated using classifier Random Forest, structural and vector proximity, the context of modeling which was based on ML and RC, was applied to determine the protein and its correspondence level [23].

In similar, the control and spread of any communicable disease depend upon the vaccine instantiated. Certainly, the development of these vaccines is not an easy task, moreover, several challenges and barriers exist to determine the effective and efficient drug which can handle the generic data. In the past several studies are introduced by researchers and health care practitioners to study the overall effect of the vaccine [17–22]. Comparably, a study was proposed to discuss the encounters of the vaccine in context with structural and attitudinal patterns in the US population [24, 25]. Where the structural barriers were discussed as the service which was not accessible such as transportation services, or going out and acquiring public services. Further, attitudinal barriers refer to the fact the beliefs which a person acquires the fear of communicable disease or his unwillingness to accept the facts due to perception of the mind. Moreover, in the context of vaccination, it may be discussed as the barrier which develops as the aftermaths or present vaccination programs and determines the risks associated with same. Similar outcomes can be controlled by several recommendation programs, where the effectiveness and importance of COVID- 19 can help them reduce the barriers among the population, which an individual acquires due to rational information [24, 25].

Method and materials

COVID 19 has substantially worn the world upside down which has created several inhibitions to detect hidden patterns and information from large scale databases. However, the current study of approach focuses on vaccine dissemination patterns around the globe. The study was based on databases generated from public domain repository of United Nations World Population Prospect, where the datasets compromise of subnational locations such as England, Northern Ireland, Scotland, Wales and others [26]. Also, the overall estimation was calculated on the basis of total vaccinations conducted with doses

administrated at each level in correspondence people fully vaccinated with per hundred million. The dataset was analyzed to measure the potential factors in context with impact of political and socio-economic factors on SARS-Cov-2 vaccination trends in different countries. The study has been synthesized on political and socio-economic factors where the features were ardently study in retrospect of varied socio- economic features which may include country wise literacy rate, overall GDP rate [27, 28]. Further, we have utilized the secondary data extracted to explore the international trends of vaccination. The current study of approach was focused to provide appropriate geographical coverage of vaccination with stratified sampling and exploratory data analysis.

Model

The exploratory data analysis (EDA) is conducted among the databases to detect hidden patterns, information and knowledge from the data. The data investigated was pre-processed for null values, missing values and inconsistent values to measure the exploratory features summarization. The proposed study was implemented using python 3.9.0 version using NumPy package, Matplotlib library and pandas to explore the complex patterns among the data. Further, data was explored with graphs and distribution curves to synthesize and identify the potential outlines in the data. The analysis also included varied statistics such as mean, median, standard deviation for varied features in the datasets.

Additionally, the study was categorized with relevance and impacting factor which were considered for vaccine dissemination in comparison with the literacy rate of the nations. Also. Target features were considered for the vaccination dissemination trends for calculating the health expenses of different nations. The study has been synthesized on political and socio-economic factors where the features were ardently study in retrospect of varied socio- economic features which may include country wise literacy rate, overall GDP rate, further we substantiated the work to address the political factors which are discussed as the country status of democratic or having other status.

Descriptive analysis

Vaccines have been one of the biggest preventive measures that were developed over the past century to tackle dreaded diseases. However, the major diseases which tends to cured with vaccination is smallpox and rinderpest which has substantially outcasted the population with their rendered threats. While Covid-19 vaccinations have once again raised the debate about a population's trust in various aspects of this process, studies were done before the pandemic also helped in understanding the factors that drive acceptance rates [29, 30].

A study done by Larson et al. in 2016 [17] had analyzed trust in vaccinations in terms of four factors, namely its importance, its safety, its effectiveness, and religious compatibility. Respondents from sixty-seven countries were surveyed for their confidence in vaccines. The survey gauged sentiment on a five-point Likert scale, where answers were discrete values of strongly agree, tend to agree, do not know, tend to disagree, strongly disagree. After the removal of the neutral answer of 'do not know', the countries were ranked based on low confidence. The countries that showed the most negative sentiment towards vaccination before the SARS-Cov-2 pandemic in terms of the four different factors are listed in Table 1.

As can be seen from the rankings, European and Western Pacific nations were least confident of vaccinations. Developed nations like Japan and France were unexpected entries. The distrust of the population of France can be attributed to the vaccine-related controversies that plagued the nation in the past two decades [31]. Japan is known to be a risk-averse nation and therefore

Table 1 The top ten countries that displayed the least trust in vaccinations before the SARS-Cov-2 pandemic

Rank	Vaccine Safety	Vaccine Importance	Vaccine Effectiveness	Religious Compatibility
1	France	Russia	Bosnia and Herzegovina	Mongolia
2	Bosnia and Herzegovina	Italy	Russia	Thailand
3	Russia	Azerbaijan	Italy	Mexico
4	Mongolia	China	France	China
5	Greece	Slovenia	Greece	Vietnam
6	Japan	Hong Kong	Slovenia	Bangladesh
7	Ukraine	Ukraine	Romania	Panama
8	Iran	Mexico	Ukraine	Kosovo
9	Slovenia	Greece	Latvia	India
10	Armenia	France	Serbia	Fiji

the population shows a major concern in vaccine safety to fully trust them [32]. Table 2 lists the top ten countries that displayed positive sentiment towards vaccines.

While the countries with positive sentiment towards vaccination are a mix of developed and developing nations, the latter were more accepting. It should also be noted that religious fundamentalism might impede vaccine acceptance, but it cannot be linked to a certain faith type, as shown by the presence of Saudi Arabia which has a majorly Muslim population [33].

The SARS-Cov-2 vaccination data was sourced from Our World in Data repository hosted on Github [22]. This dataset is comprised of two hundred and seventeen countries spread across the six continents. Table 3 lists the attributes of the data that was accessed till July 2021.

The data repository also contained information on Covid vaccines that were administered till the time of this study. These were Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac, SputnikV, JohnsonandJohnson, Moderna, Covaxin, CanSino, Sinopharm/Wuhan, Abdala, Soberana02, QazVac, Sinopharm/HayatVax, EpiVacCorona, RBD-Dimer [22]. Their usage breakdown is shown in Table 4. The three vaccines that have been administered in the majority are Oxford/AstraZeneca, Pfizer/BioNTech, and Moderna.

Our analysis also aimed to discern the effect of a nation's political regime on the SARS-Cov2 vaccination dissemination. While Authoritarian governments are associated with strict implementation of policies among the residents, democracies offer a choice to its residents. The said choice may take stricter forms in case of emergencies like a pandemic. Therefore, some democracies also saw strict regulations regarding the SARS-Cov2 vaccination dissemination. Nonetheless, we combined the political regimes of different nations [26] for this particular analysis. The dataset contained political regime values as Polity 2 Measure ranges from -10, which corresponded to autocracy, to + 10 for full democracy. For

Table 2 The top ten countries that displayed the most trust in vaccinations before the SARS-Cov-2 pandemic

Rank	Vaccine Safety	Vaccine Importance	Vaccine Effectiveness	Religious Compatibility
1	Finland	Kosovo	Australia	Argentina
2	Algeria	Iceland	Tunisia	Bulgaria
3	Ethiopia	Ethiopia	Denmark	Portugal
4	Portugal	Brazil	Finland	Sweden
5	Indonesia	Vietnam	Saudi	Morocco
6	Ecuador	Philippines	Iceland	Armenia
7	Philippines	Argentina	Philippines	Australia
8	Saudi Arabia	Ecuador	Ethiopia	Brazil
9	Argentina	Iran	Ecuador	Saudi Arabia
10	Bangladesh	Bangladesh	Argentina	Finland

Table 3 The attributes of the vaccination data sourced from Our World in Data repository

Attribute Name	Description
location	Name of the country or a geographical region
iso_code	Three letter country code
date	date of the observation
total_vaccinations	total number of doses administered
total_vaccinations_per_hundred	total number of doses administered per hundred persons
daily_vaccinations_raw	daily change in the total number of doses administered
daily_vaccinations	new doses administered per day smoothened over seven days
daily_vaccinations_per_million	new doses administered per day smoothened over seven days per 1,000,000 persons
people_vaccinated	total number of people who received at least one vaccine dose
people_vaccinated_per_hundred	total number of people who received at least one vaccine dose per hundred persons
people_fully_vaccinated	a total number of people who received all doses prescribed by the vaccination protocol. Includes both doses of vaccine, if applicable
people_fully_vaccinated_per_hundred	the total number of people who received all doses prescribed by the vaccination protocol per hundred persons. Includes both doses of vaccine, if applicable

Table 4 The percentages breakdown of SARS-Cov-2 vaccines used till July 2021 across the world

Vaccination	Usage
Pfizer/BioNTech:	17.55%
Sputnik V:	7.08%
Sinovac:	6.98%
Sinopharm/Beijing:	10.04%
Oxford/AstraZeneca	19.56%
CanSino:	2.85%
Moderna:	12.05%
Covaxin:	3.28%
JohnsonandJohnson:	10.89%
Sputnik Light:	3.07%
Novavax:	3.49%

the ease of analysis, the Polity indices were categorized as Authoritarian where the measure ranged between -10 to -6, Limited Authoritarian for Polity measures of -5 to -1, Limited Democracy for 0 to 5, None for non-specified values, and finally Democracy for values 5 to 10. The conversion helped in converting the feature to a categorical distribution.

Results and discussion

The proposed analysis aimed to reveal the impact of political and socio-economic factors on SARS-Cov-2 vaccination trends in different countries. The political regimes of different nations were fetched from Our World in Data repository [26] to discern the distribution of regimes and the vaccination trends. The dataset contained political regime values as Polity 2 Measure ranges from -10, which corresponded to autocracy, to + 10 for full democracy. For ease of analysis, the Polity indices were categorized as Authoritarian where the measure ranged between -10 to -6, Limited Authoritarian for Polity measures of -5 to -1, Limited Democracy for 0 to 5, None for non-specified values, and finally Democracy for values 5 to 10. Additionally, Authoritarian rule means that the people have to obey the rule and regulations formed by the single political leader. In this rule, the government doesn't have an established system where the powers can be transformed and the liberal rights can be granted to the people. So, the authoritarian rule confers to the fact that no democracy is granted and hence the people have to subsidies on the rules created by the leader. A limited Authoritarian government is the one where the legalized forces are restricted and obey the rules of authorities. Also, the laws and their restriction on individuals and business are controlled with fewer restriction. Hence, difference between limited authoritarian and authoritarian is constitutional powers are limited in case of limited authoritarian whereas all the powers are controlled by single political leader in case of authoritarian. The democratic rule implies that the power which is elected by the people. It means the people will elect their own minister and hence govern themselves in indirect way. So, democratic way of rule is for the people, by the people and of the people to maintain the freedom at each level. Limited democratic rule can be discussed as the power which restricts the leaders to have absolute power with the inclination towards the lawmakers to abide by the absolute powers created by the government. Also, limited powers are gained by the high-profile individuals and also citizens are required to adhere with the constitutional powers. Hence, Fig. 1 shows the distribution of the five types of political regimes among the vaccination data and democracy emerged as the most common form of governance.

In, Figs. 2 and 3 the illustrated images identify the vaccination trends and vaccines used by the compared nations for varied authoritative and democratic governances.

The comparison of trends shows that dissemination of the SARS-Cov-2 vaccine has been done between the two opposing types of governance. Both types have used a combination of vaccines and the graphs show a rising trend thus marking extensive acceptance among the citizens.

The next impacting factor that was considered for vaccine dissemination was the literacy of the nations. The WHO literacy rates from the year 2016 [27] were used to shortlist nations with the lowest and highest literacy rates. The shortlisted nations were then analyzed for preferred vaccines and dissemination trends. Figures 4 and 5 show trends for nations with the lowest and highest literacy rates respectively.

A country's literacy rate is an indicator of its economy and living standards. In agreement with this statement, the vaccination trends show that nations with the poorest literacy rates have extremely low and flat growth curves for vaccination numbers. On the other hand, the nations that have the highest literacy rates boast of good living conditions and better vaccination figures. These nations also used a combination of multiple vaccines for the faster safeguard of their population.

Another impacting factor that this study focused on was the vaccination dissemination trends in comparison with the health expenses of different nations. Each nation sets aside a percentage of the GDP towards the betterment of healthcare and its implementation. The health expenditure data hosted by the World Bank for the year 2018 [28] was used to get expenditure figures of the nations. Figures 6 and 7 show trends for nations with the lowest and highest healthcare expenses respectively.

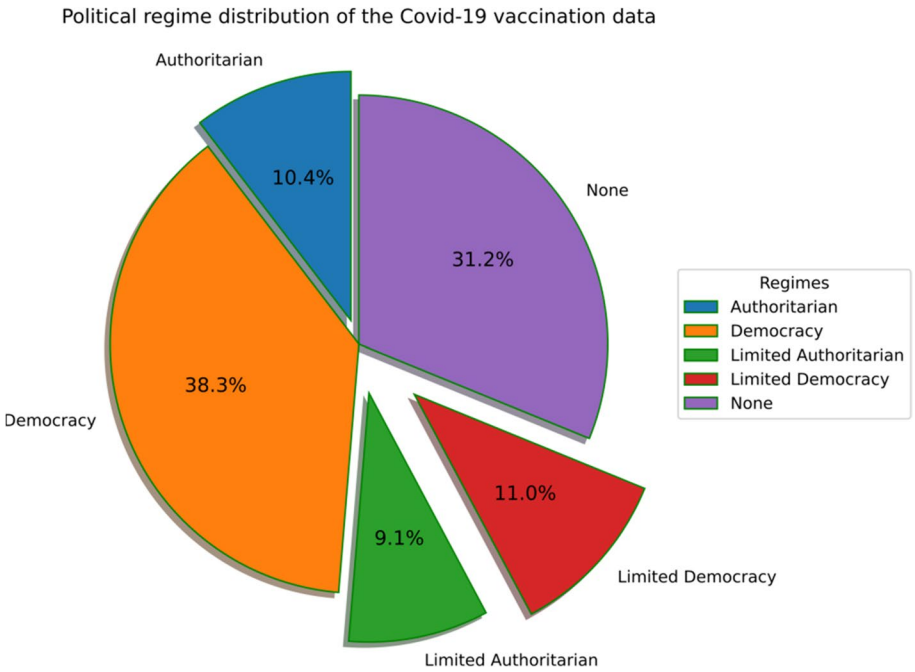
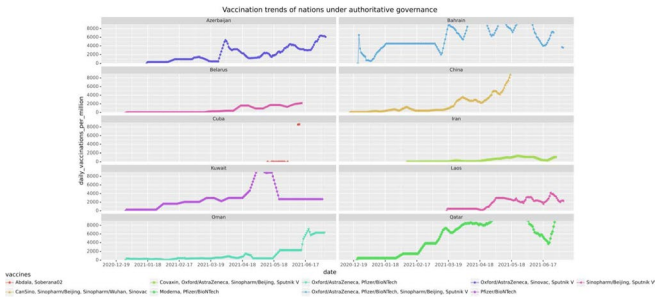
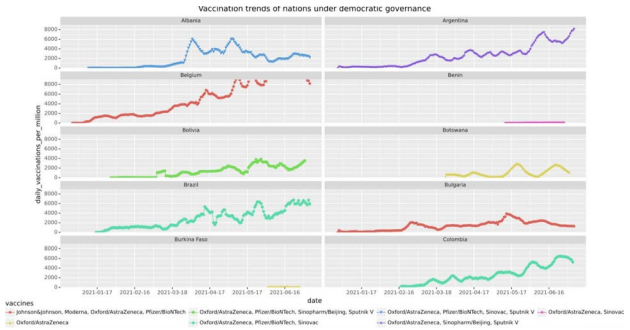


Fig. 1 The percentages breakdown of political regimes for countries that were surveyed for SARS-Cov-2 vaccination



Vaccination Trends of Nation under Authoritarian Govt										
Dates	Azerbaijan	Bahrain	Belarus	China	Cuba	Iran	Kuwait	Laos	Oman	Qatar
2021-03	959	5238	42	250	8664	43	263	391	255	501
2021-04	545	5238	48	810	10113	90	2064	2613	363	1946
2021-05	2587	9738	284	624	8312	725	2449	2100	599	6782
2021-06	1485	12491	1291	3029	15263	1063	5380	2369	1163	8740
2021-07	3171	9431	1529	6931	15581	655	2711	6600	2500	13049
2021-08	3843	5017	2758	11568	7933	5061	2711	2134	6719	5067
2021-09	5083	3864	3014	7315	3260	4802	1632	2462	3155	7998
2021-10	5169	2980	2145	9419	5681	10798	8482	2462	13119	7465
2021-11	3179	1627	3220	4315	4015	11566	8482	4693	8979	4100
2021-12	2878	4038	4321	757	1076	4081	8482	4693	7749	1227
2022-01	2635	2714	4493	6099	1286	4397	8482	6381	1747	1386
2022-02	2546	5867	7229	5849	5953	5539	3792	4230	4447	3101
2022-03	3239	3051	5899	5301	5055	2321	1842	4041	3103	6893
2022-04	1559	979	3349	1016	2392	1366	2350	1157	1718	6387
2022-05	796	475	2677	3357	3853	440	2453	340	972	3352

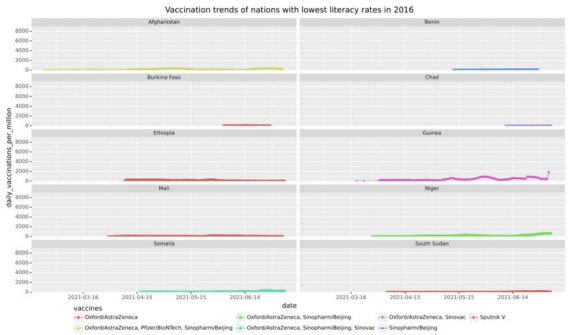
Fig. 2 The vaccines used and vaccination trends of nations under authoritarian rule



Vaccination Trends of Nation under Democratic Govt										
Dates	Albania	Argentina	Belgium	Benin	Bolivia	Botswana	Brazil	Bulgaria	Burkina Fa	Colombia
2021-03	25	203	1440	62	647	571	1187	185	25	1342
2021-04	292	1452	1585	35	712	2468	1637	2110	7	1834
2021-05	3930	1569	3906	27	2227	2392	3615	1425	56	2916
2021-06	4736	3184	5277	303	3181	1174	3232	1971	111	4290
2021-07	1490	2503	8137	218	3308	843	4658	2026	1630	7559
2021-08	1850	5707	11294	469	5735	993	5694	1429	124	4094
2021-09	2700	7676	10000	2639	6550	5330	7897	1256	654	3073
2021-10	4080	8084	3115	1272	2091	1039	6754	1420	1219	4924
2021-11	2289	6019	1556	1192	3656	1039	4890	962	233	6734
2021-12	1851	7880	1891	1454	2279	1039	5686	1900	166	4784
2022-01	2260	5752	4198	131	2747	444	3649	2373	936	4700
2022-02	1994	5813	10599	0	3519	3208	3153	1941	29	4503
2022-03	5738	7167	6523	166	1824	3682	5666	1940	0	2577
2022-04	922	3825	2482	0	1094	11150	4573	610	429	1342
2022-05	626	2163	516	0	799	75	2975	228	1142	1906

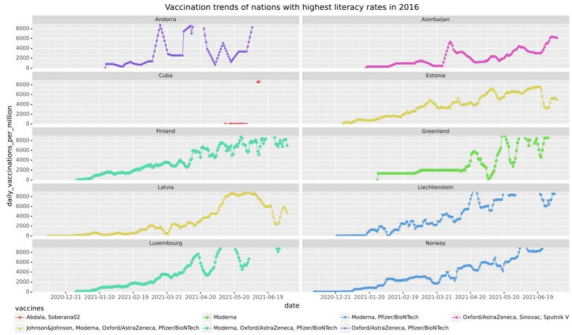
Fig. 3 The vaccines used and vaccination trends of some democratic nations

The curves are strong indicators that the nations that spend more on healthcare were the ones that had the best SARS-Cov-2 vaccination rollout. These nations used a large number of vaccines to administer to their population and the trends were positive growth. While the nations with the lowest healthcare expenses failed



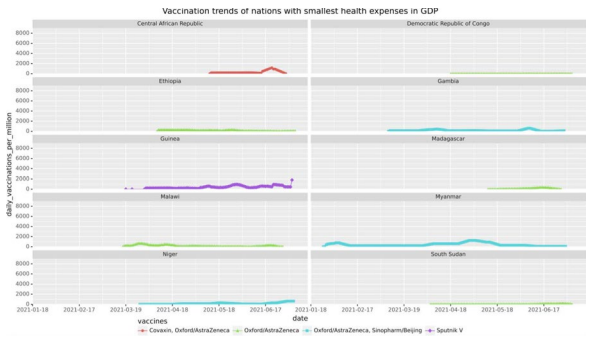
Vaccination Trends of Nations with Lowest Literacy Rate										
Dates	Afghanist	Benin	Burkina Fa	Chad	Ethiopia	Guinea	Mali	Niger	Somalia	South Sud
2021-03	73	62	25	72	201	199	80	111	4	15
2021-04	195	35	7	44	90	302	186	181	124	22
2021-05	128	27	56	114	46	554	41	247	157	111
2021-06	316	303	111	149	58	360	20	141	8	0
2021-07	377	218	1630	51	97	348	86	25	288	10
2021-08	27	469	124	112	242	906	85	41	406	56
2021-09	316	2639	654	144	526	1388	2	296	1938	128
2021-10	891	1272	1219	71	2183	536	717	23	720	280
2021-11	594	1192	233	37	97	160	288	716	286	74
2021-12	371	1454	166	7957	3	141	98	37	170	267
2022-01	246	131	936	12	3488	222	158	83	1662	150
2022-02	364	0	29	9	12	1742	363	17	278	403
2022-03	268	166	0	1529	2366	319	0	5	79	251
2022-04	116	0	429	1529	11	55	404	3	1003	2156
2022-05	173	0	1142	6	7541	252	418	644	492	297

Fig. 4 Vaccination trends with the lowest literacy rates in the year 2016



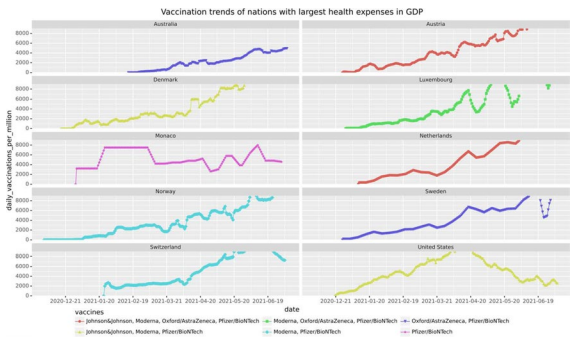
Vaccination Trends of Nations with Highest Literacy Rate										
Dates	Andorra	Azerbaija	Cuba	Estonia	Finland	Greenland	Latvia	Liechtens	Luxembou	Norway
2021-03	751	959	8664	841	1454	1363	178	711	933	61
2021-04	2530	545	10113	2249	2777	2000	412	2439	1575	1296
2021-05	6425	2587	8312	3382	3276	5399	1275	2363	2716	2911
2021-06	3219	1485	15263	4080	5530	3452	1427	6251	3308	3956
2021-07	18123	3171	15581	6362	7254	8550	4742	8029	5588	5913
2021-08	11648	3843	7933	4215	7705	12639	9202	10215	9926	6787
2021-09	3807	5083	3260	4714	7063	4992	5025	7038	6106	10027
2021-10	2730	5169	5681	2770	6498	1929	2838	5158	1651	6875
2021-11	827	3179	4015	2577	4123	903	2801	5412	1053	12579
2021-12	676	2878	1076	2657	2982	230	3465	584	2336	3295
2022-01	1378	2635	1286	4378	3057	549	6402	940	4183	1099
2022-02	9857	2546	5953	4473	4610	920	5366	17406	9231	5715
2022-03	11560	3239	5055	3004	8317	35	3579	8639	9058	4905
2022-04	175	1559	2392	806	714	0	3216	1525	1322	6566
2022-05	150	796	3853	360	765	0	780	381	463	626

Fig. 5 The vaccines used and vaccination trends of nations with the highest literacy rates in the year 2016



Vaccination Trends of Nations with Lowest Health Expenses in GDP										
Dates	Central Af	Democrat	Ethiopia	Gambia	Guinea	Madagasc	Malawi	Myanmar	Niger	South Sud
2021-03	158	4	201	329	199	217	434	226	111	15
2021-04	126	13	90	110	302	42	104	226	181	22
2021-05	15	10	46	471	554	42	155	792	247	111
2021-06	266	1	58	27	360	98	34	299	141	0
2021-07	619	14	97	1336	348	208	569	94	25	10
2021-08	90	4	242	361	906	47	215	997	41	56
2021-09	374	16	526	450	1388	271	324	1197	296	128
2021-10	645	55	2183	344	536	249	233	3237	23	280
2021-11	1244	58	97	104	160	193	475	6277	716	74
2021-12	1404	120	3	746	141	148	246	4491	37	267
2022-01	139	8	3488	173	222	84	57	3981	83	150
2022-02	902	293	12	1392	1742	84	207	3382	17	403
2022-03	105	340	2366	1392	319	84	67	3680	5	251
2022-04	1387	401	11	1392	55	84	211	5309	3	2156
2022-05	18	83	7541	1225	252	135	1173	2136	644	297

Fig. 6 The vaccines used and vaccination trends of nations with the lowest expenditure on healthcare



Vaccination Trends of Nations with Highest Health Expenses in GDP										
Dates	Australia	Austria	Denmark	Luxembourg	Monaco	Netherlands	Norway	Sweden	Switzerla nd	United States
2021-03	710	1412	1161	933	8057	1575	61	1258	1095	2638
2021-04	2327	1663	1565	1575	8057	2024	1296	2322	2147	5314
2021-05	2760	4107	2942	2716	4768	3750	2911	3349	2454	7724
2021-06	3948	5670	2523	3308	3206	6052	3956	5428	4904	10554
2021-07	5484	8128	6757	5588	4549	9893	5913	6970	7845	5784
2021-08	9283	9494	8646	9926	5070	11325	6787	9394	10057	3281
2021-09	10616	5972	10664	6106	6276	6627	10027	5505	6014	1383
2021-10	10362	2212	8010	1651	6138	1455	6875	6261	2244	2138
2021-11	4795	1851	2764	1053	4330	868	12579	2337	3661	2078
2021-12	5333	2424	948	2336	4330	951	3295	2744	2800	2695
2022-01	10630	11108	2284	4183	4330	3235	1099	5793	2383	4220
2022-02	6012	10687	5623	9231	0	13833	5715	2914	7901	5550
2022-03	3088	4504	9614	9058	0	2031	4905	6799	7461	2947
2022-04	1923	992	1855	1322	0	665	6566	2309	1264	1606
2022-05	1907	384	300	463	0	3047	626	1539	264	694

Fig. 7 The vaccines used and vaccination trends of nations with the highest expenditure on healthcare

to keep up with the demand and depended on vaccines donated by other countries to protect their population. The curves grew slowly over time, while some were flat and showed slow progress.

Conclusion

The human race has progressed through several inventions, and vaccines have been one of the most important of them all.

While vaccines have been successful in improving the life expectancy of the masses, the technology is still riddled with distrust and negative sentiment among the masses. This sentiment gets further aggravated due to controversies and low confidence in scientific research. It is but evident that the difference in ideology can be attributed to the demographics that the persons with negative sentiment belong to. The ideology of a person is governed by their cultural background and the other conditions that prevail in their country. These may include political factors like the government regime, economic factors like GDP and generic economic status, and literacy rates.

In this paper, we have analysed how vaccination dissemination and acceptance were affected by the political and socio-economic factors where the features were ardently study in retrospect of varied socio- economic features which may include country wise literacy rate, overall GDP rate and others. While, the world is battling with the global pandemic of SARS-Cov-2, sentiment towards vaccination has again come into the limelight. The authors have analyzed the confidence in vaccinations before the Covid pandemic happened and found that the European and Western Pacific nations were least confident. Japan, known to be a risk-averse nation also showed a major concern in vaccine safety to fully trust them. The countries with positive sentiment towards vaccination were a mix of developed and developing nations. In the post-Covid scenario, the analysis showed that the dissemination of the SARS-Cov-2 vaccine had been comparable between the authoritarian and democratic types of governance. The vaccination trends also showed that the nations with the poorest literacy rates had extremely low and flat growth curves for vaccination numbers. The nations that spent more on healthcare were the ones that had the best SARS-Cov-2 vaccination rollout. These nations used a large number of vaccines to administer to their population and the trends were positive growth. While the nations with the lowest healthcare expenses failed to keep up with the demand and depended on vaccines donated by other countries to protect their population. With this analysis, the authors hope that better vaccination strategies can be drafted as suited to the geopolitical factors of different countries.

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Authors' contributions
R.C & G.V wrote the main manuscript. The theoretical concept was designed by R.C while the structural content and framework was designed by E.Y & M.F.Z. The implementation of research was conducted by R.C and G.V. The author(s) read and approved the final manuscript.

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Availability of data and materials
The qualitative data extracted and analysed during the current study is publicly available but can be discussed or made available from the corresponding author on reasonable request. All documents analysed are publicly available and referenced in this article.

Declarations

Ethics approval and consent to participate
The data used for the analysis was published by Our World in Data under the Creative Commons BY license. All methods were performed in accordance with the relevant guidelines and regulations. The datasets generated and/or analyzed during the current study are available in the following repositories. https://github.com/owid/covid-19-data/blob/master/public/data/vaccinations/README. https://github.com/owid/owid-datasets/tree/master/datasets/Cross-country%20literacy%20rates%20-%20World%20Bank%2C%20CIA%20World%20Factbook%2C%20and%20other%20sources. https://data.worldbank.org/indicator/SH.XPD.CHEX.PC.CD.

Not applicable.

Consent for publication
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Competing interests
The authors declare no competing interests.

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