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Research Article

COVID-19 Vaccination: Hopes and Facts to Cover Incompetence

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ABSTRACT

Background: Vaccination programmes against COVID-19 started in December 2020 in three countries (Israel, the UK and the USA) and in the first two weeks of January in a further 137 countries. No vaccination campaigns had yet been implemented in 36 countries on 30 March 2021.

Objective: The aim of this research is to compare the death rates in the two sets of countries. The correlation between number of deaths due to the virus and LEEDELS data (Life Expectancy, Ecological, Demographic/Social and Lifestyle variables) was calculated to determine which of these variables were connected with COVID-19 deaths.

Methods: The death and vaccination data were retrieved from the WHO coronavirus dashboard. The LEEDELS data were taken from the Atlante Geografico Agostini 2020 and CIA World Facebook 2020-2021. The statistical evaluation was conducted using the Spilt-Plot variance analysis. The profiler analysis was used to assess the correlation between deaths and vaccinations and the Spearman's ρ were used to correlate the COVID-19 deaths to LEEDELS.

Results: 176 countries were considered. Death rates in the 36 countries without a vaccination programme are increasing, while in few of the other 140 which are close to herd immunity the rate seems to be flattening. However, a significant increase in number of deaths was seen in 48 of the 140 countries (34%) with vaccination programmes despite their campaigns. Death from the virus is linked to urban density and the variables that reflect prosperity (GDP, hospital beds, cars and the internet). None of the other variables were correlated.

Conclusion: COVID-19 is causing a tragic number of deaths and vaccination is only one of the tools needed to tackle the disease. It can be ineffective without an appropriate approach to health policy. The poorest countries will be the next victims.

Keywords: COVID-19; Vaccination; LEEDELS

INTRODUCTION

Data regarding deaths due to COVID-19 were available for 176 countries on 30 March 2021, along with a complete set of LEEDELS data (life expectancy, ecological, demographic/social and lifestyle variables). Only 140 countries had begun a vaccination programme before 30 March 2021, while the remaining 36 countries had not yet started a campaign [1].

There are at least nine vaccines currently available (Table 1). All are being used in their country of origin and have been delivered and administered to other countries too upon request. More than one vaccine is being used to cover the needs in some countries. As regards vaccine efficacy, we only have the data the pharmaceutical companies have given to the health authorities, and very few other published reports regarding individual countries.

It is common belief that vaccines should be immediately available once approved. Moreover, the theory that herd immunity is sufficient to protect the population fully against COVID-19 still has to be confirmed since we are discovering new peculiar characteristics of this virus every day.

The aim of this research is to establish the effects of vaccination on COVID-19 mortality rates in the 136 countries which have already started vaccinating, and compare these data with those of the 36 countries where a programme has not yet been implemented. The relationship between COVID-19 death rates and LEEDELS data was also analysed.

MATERIALS AND METHODS

The weekly vaccine shot and death due to COVID-19 data was taken from the WHO Coronavirus Dashboard [1]. A total of 176

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countries were considered and the relationship between death rates and LEEDELS data was calculated for these countries. The LEEDELS data (Life Expectancy, Ecological, Demographic And Lifestyle variables) for the year 2020 were taken from the Atlante Geografico De Agostini and CIA World FactBook 2020-2021 [2-4].

The LEEDELS data consist of:

Life Expectancy (years): LE

Population Density (inhabitants/Km^2): PD

Urban Population (% of inhabitants in cities): UP

GDP (Gross Domestic Product in USD): GDP

Education (% of GDP for education): ED

Hospital Beds (number of beds/1000 inhabitants): HB

PM 2.5-10 (mg/m^3): PM

Cars (number of cars/1000 inhabitants): CA

Mobile Phones (number of mobile phones/1000 inhabitants): MP

Internet (number of connections/1000 inhabitants): IN

Percentage of land covered by forests: FT

Statistical evaluation

Mean values and standard deviations were calculated for all the LEEDELS data. The statistical significance of differences was calculated using the Mann–Whitney U test. The Split-Plot analysis of variance was used to compare the deaths of the countries using the vaccination and the other countries. The profiler analysis and the Spearman's ρ was used to assess any correlation between deaths and vaccinations. All the analyses were done using JMP14 Pro software produced by the SAS institute.

RESULTS

The general picture

Data on the number of deaths due to COVID-19 in 176 countries were considered. However, the number of vaccine shots was only recorded for 140 [1]. The total number of deaths due to COVID-19 up to 28 December in the 176 countries concerned came to 1,835,720. On this date, vaccination had started in the UK, the USA and Israel only (7, 14, and 19 December respectively), and the effect of these campaigns on the death rate in the world on 28 December was very limited. Most of the countries which decided to aim for vaccine coverage started administrations in the first two weeks of January. The trend in deaths from January 2020 to the week ending 29 March is shown (Figure 1).

A decrease in death rate in the world started to become evident from the week of 1 February. It slowly went down until the week ending 7 March, after which the number of deaths started to fluctuate and grow again. Nine vaccines were available for human use, but only three were approved by the FDA and EMA and were in use on 30 March. Furthermore, the three vaccines approved by China were also used in some countries other than China. The only vaccine prepared in Russia was also used in some other countries besides Russia. There is not sufficient information about the vaccines used outside their country of origin. Therefore, no data is available regarding their efficacy except for the trials carried out by the various producers [5-15]. Table shows the vaccines currently in use (Table 1). As already mentioned, some of them are only used in their country of origin and may be made available upon request.

A total of 547,727,346 shots of vaccine had been administered in the world on 30 March, and data are available on how much of each of them has been administered in all 176 countries. In the month of December and during the first two weeks of January, 140 countries decide to start the vaccine campaign and the deaths trends from January 4 up to March 29 are reported (Figure 2). The same data are reported in figure for those countries not implementing the vaccination campaign (Figure 3).

From the Figures 2 and 3 it is evident that the deaths rate in those countries not using the vaccines was lower than in the countries which decided to start with the vaccinations. However, between the weeks of January 1 and March 29 in those countries not yet implementing the vaccine campaign the deaths trend started slowly to grow doubling the number of deaths, while in the countries using vaccines the deaths were slowly reduced. The data of the two sets of countries were compared using the Split-Plot variance analysis (Figure 4) and the Least Square Mean Plot analysis (Figure 5). The average values and the relative trends are summarized in Figure 5.

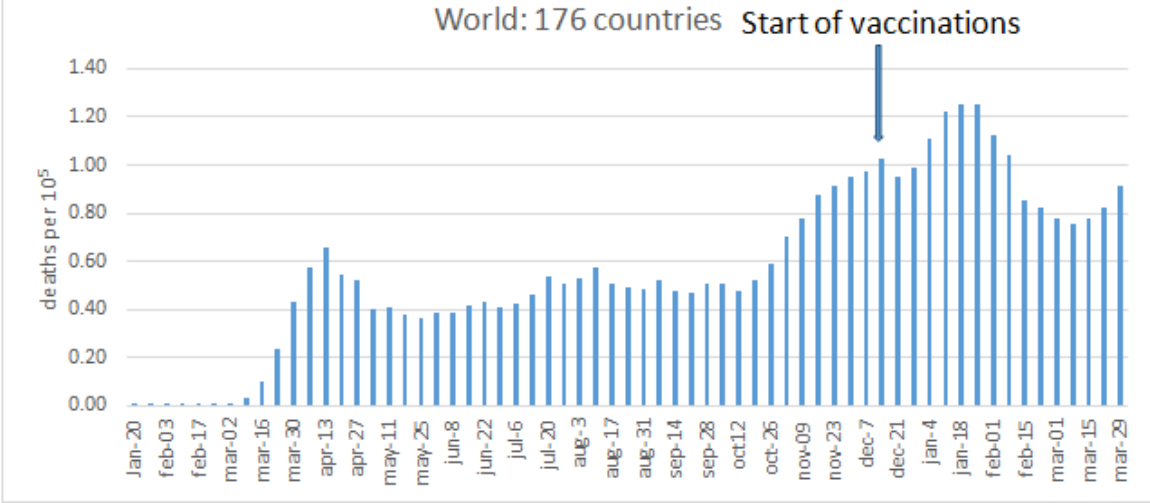

Figure 1: Deaths in 176 countries: weekly data from January 2020 to 29 March 2021.

Table 1: Vaccines currently available in the world.

Vaccine name Country	Kind of vaccine	Producer	Countries where it is in use	Efficacy % doses	Ref
mRNA-1273 A USA	mRNA	Moderna	USA, UK, Switzerland Others [b]	94	5
BNT1262b2 A USA/Germany	mRNA	Pfizer – BioNTech	SA, EU, Others [b]	95	6
ChAdOx1 A USA/Sweden	Non replicating Viral vector	AstraZeneca/Oxford	UK, Brazil, EU, Others [b]	67	7
Gam-COVID-Vac Russia	Viral vector "Sputnik"	Gamaleya Res Center	Russia, Others [b]	92	8
Sinopharm China	Inactivated virus	Sinova Biothec	China, UAE c,Bahrein, Others [b]	86	9
Coronavac China	Inactivated virus	Sinovac Biotech	China, Others [b]	50-79	10
Ad26.COV2.S USA/Germany	Non replicating Viral vector	Johnson & Johnson	USA, EU, Others [b]	66	11
Ad5-nCov China	Non replicating Viral vector	Cansino Biologics	China, Mexico, Pakistan	65.7	12
BBV152 India	Inactivated virus	Barat	India, Iran, Zimbawe	81	13
EpiVacCorona Russia	Subunit virus	Vector Institute	Russia	100	14
NVX-CoV2373 USA	Subunit virus	Novavax	Under study	89	15

b=other countries

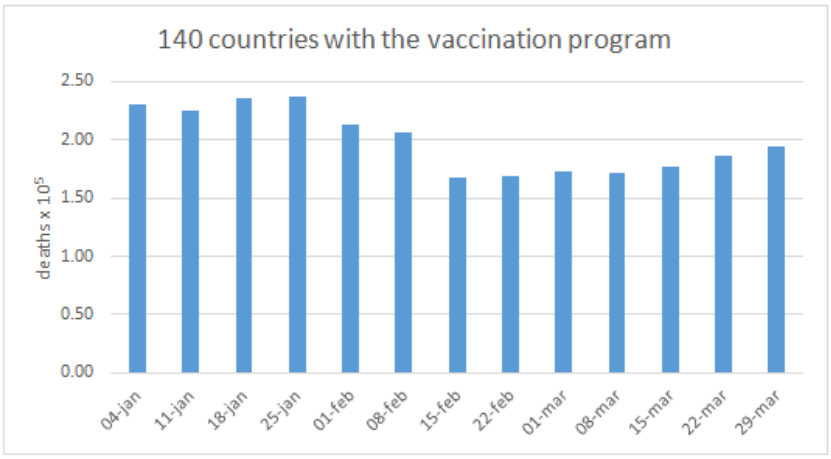

Figure 2: Deaths due to COVID-19 in the 140 countries which started the vaccination program between December 7 2020 and January 15 2021.

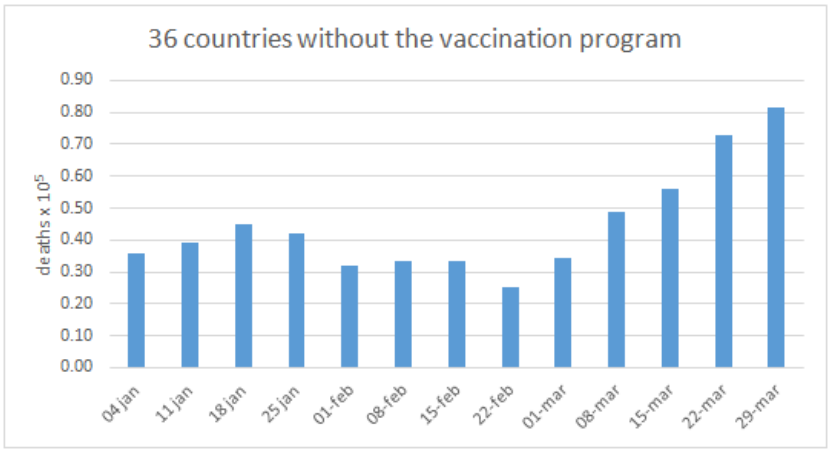

Figure 3: Deaths due to COVID-19 in the 36 countries that at March 30 were not starting with the vaccination program until March 30 2021.

Effect Summary

Source	LogWorth	PValue
Vaccine	2,756	0,00176
Vaccine*Time	0,865	0,13657
Time	0,484	0,32818

Summary of Fit

RSquare	0,848497
RSquare Adj	0,847102
Root Mean Square Error	1,20503
Mean of Response	1,601986
Observations (or Sum Wgts)	549

Fixed Effect Tests

Source	Nparm	DF	DFDen	F Ratio	Prob > F
Vaccine*Time	2	2	362	2,0019	0,1366
Vaccine	1	1	181	10,0871	0,0018*
Time	2	2	362	1,1176	0,3282

Figure 4: Variance Spit-Plot analysis comparing the deaths in the countries using vaccine (140) *Vs* those not using vaccine (36) against COVID-19.

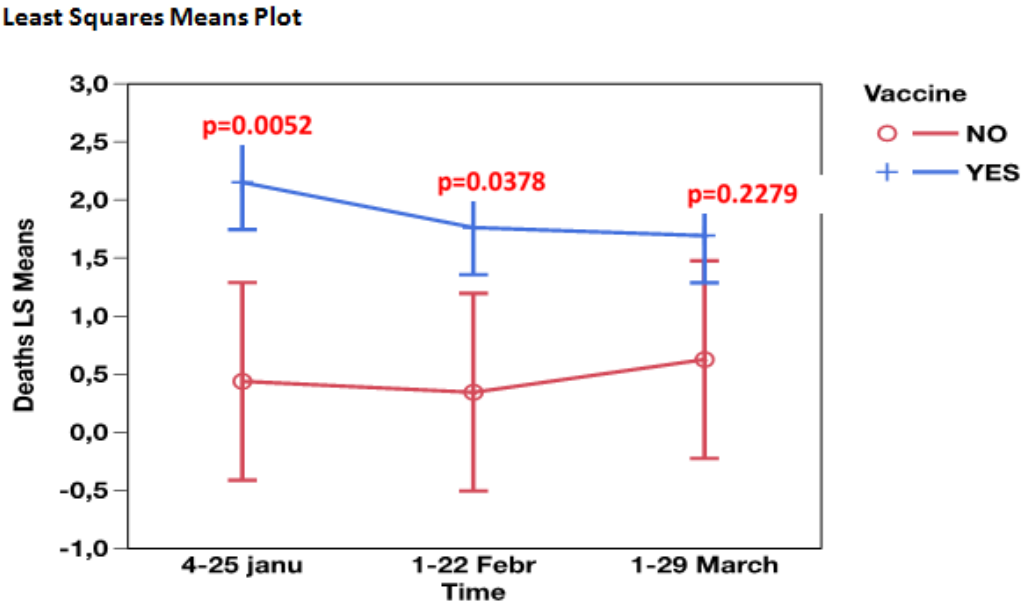

Figure 5: Plot analysis: averages of deaths x 10^3 in the countries using vaccine (140) *Vs* those not using vaccines (36): period between January 4 to March 29 2020.

In the period between 4/25 January the countries using vaccinations showed significant higher death rates than the other countries. This difference is not any more significant in the following periods (1/22 Feb and 1/22 March) due to the reduction of deaths in the countries using vaccine and the increase of deaths in the other countries.

These differences may be due to impact of the Life expectancy, Demography/Social, Ecological, and Life style variables (LEEDELS).

Deaths due to COVID-19 in relation to LEEDELS data

The relationship between number of deaths due to COVID-19 (up to 28 December) and life expectancy, ecological, demographic/social, and lifestyle variables (LEEDELS) in the 176 countries under analysis. Table shows the results (Table 2).

COVID-19 shows significant direct correlation with all variables associated with the prosperity of a country such as GDP, hospital beds, cars, mobile phones, and internet connections. The negative correlation with PM could be interpreted as a secondary effect of the tendency in the most prosperous countries to reduce pollution.

Other variables were also considered such as the percentage of people over 65 years of age, the ratio between 65-year-olds/other ages, and the percentage of land covered by forests. None of these further variables were correlated with COVID-19 deaths.

Vaccinations

In theory, the effect of any vaccination on the mortality rate will take some time to become evident. COVID-19 is a new disease, which was not around in the past, and no data are available to determine the efficacy of any vaccine. In this review we have tentatively calculated their effect considering the time needed for symptoms to emerge, which is about 5 days on average, and for death to occur, which is 2 to 3 weeks after the symptoms appear.

In other words, at least four weeks have to pass before a vaccination campaign could lead to a decrease in death rate in a population. For this reason, we compared two time periods to calculate the effect of vaccination on mortality rate:

a) The four weeks immediately after the start of the vaccination campaign, which correspond to the plateau in the world death rate curve (see Figure 1).

b) The four weeks starting from one month after the start of the vaccination campaign, which is the period in which some initial activity of the vaccinations should be seen according to the number of shots administered.

The number of shots administered was very different in each country, with values from 0 per 10^3 inhabitants (in 36 countries) up to 1353.78 per 10^3 inhabitants (United Arab Emirates). Values above 1000 are due to the need for two shots/inhabitant (complete coverage of the population would be 2000 per 10^3).

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COVID-19 vaccine is rarely administered to children under 15 years old. This means that the values shown in Table 2 underestimate the real coverage of the over-15-year-old population by at least 10% (13.2% of world inhabitants are under 16 years old). In the age pyramids of world countries, the differences in the percentages of under 15-year-olds does not exceed 5%. Therefore, the number of vaccine shots/people shown in Table 2 is minimally affected by the age structure of the country.

The differences between the period January 4/22 (baseline period) and March 2/29 (after vaccinations) was calculated for each country and reported as DJM (difference January/March) as deaths × 10^3 inhabitants . The data are summarized (Table 4).

Table 2: COVID-19 Deaths × 10^3 at December 28 2020 in 176 world countries and the relative LEEDELS.

Country	COVID[n] (× 10^3)	LE[o] (years)	PD[p] (inh/Km^2)	PU[q] (%)	GDP[r] (USD	ED[s] (% GDP)	HB[t] (× 10^3)	PM[u] (mg/m^3)	CA[v] (× 10^3)	MP[z] (× 10^3)	IN[w] (× 10^3)
Afghanistan	0.075	66.0	46	25.3	588	3.2	0.5	62.9	44	106	106
Albania	0.418	79.0	100	58.4	4583	3.5	2.9	14.6	140	1194	664
Algeria	0.066	77.5	18	71.3	4292	4.3	1.7	37.2	93	1207	429
Andorra	1.047	82.5	171	84.6	36987	3.3	2.5	10.9	686	1044	979
Angola	0.014	62.2	23	44.8	4408	3.4	1.1	36	3.3	447	130
Antigua Barb.[a]	0.050	77.5	227	23.4	1672	2.4	2.1	15.7	nr	1783	730
Argentina	0.984	77.2	16	91.9	14467	5.9	4.7	14	241	1398	710
Armenia	0.954	75.6	100	63.7	3861	2.8	4.2	27	76	1190	664
Australia	0.037	83.9	3	89.6	55707	5.2	3.8	6.1	568	1127	866
Austria	0.730	82.1	105	66	47290	5.4	7.4	15	554	1709	879
Azerbaijan	0.266	73.3	113	53	4141	3	4,9	33	118	1031	790
Bahamas	0.473	74.3	28	83	31255	3.6	2.9	12.8	258	894	800
Bahrain	0.247	77.7	1830	88.8	24029	2.7	2.0	79.7	351	1584	959
Bangladesh	0.047	73.6	1086	33	1602	2.5	0.6	101	2.4	881	182
Barbados	0.025	79.6	661	31.4	17859	5.1	6.2	18.4	292	1182	796
Belgium	1.779	82.2	371	97.9	43852	6.6	5.7	16	507	1046	877
Belize	0.642	75.1	17	44.8	4806	7.4	1.1	20.2	93	619	446
Benin	0.004	62.8	95	44.5	830	4.4	0.5	96	3.3	785	120
Bhutan	0.000	72.8	19	37.8	2903	7.4	1.7	55.8	56.3	905	418

Belarus	0.152	75.2	46	78.1	5760	5.0	8.5	19.8	320	1206	744
Bolivia	0.824	72.4	10	68.9	3353	7.3	1.1	22.0	30.4	992	397
Bosnia	1.069	77.9	67	39.9	5149	nr	3.5	39.3	215	981	695
Botswana	0.019	69.9	4	57.7	7787	9.5	1.8	23.1	117	1314	394
Brazil	0.941	76.6	24	85.9	9895	5.9	2.3	12.7	173	1130	609
Brunei	0.007	76.4	73	75.5	27912	4.4	3.3	6.4	296	1271	900
Bulgaria	1.902	75.5	64	73.5	8064	4.1	7.3	25.6	443	1204	634
Burkina Faso	0.004	63.0	73	30.7	664	4.2	0.4	110.7	10	935	140
Burundi	0.000	62.7	403	12.4	312	5.4	1.9	46.3	2	545	52
Cambodia	0.000	70.5	88	20.9	1390	1.9	0.7	26.1	18	1160	340
Cameroon	0.020	60.3	47	54.9	1041	3	1.3	139.7	11.6	819	232
Canada	0.425	83.0	4	82	45077	5.3	2.6	7.5	618	859	912
Cabo Verde	0.210	73.6	133	66.2	3238	5.4	2.1	66.6	59.5	1121	572
Centr. Afr. R.[b]	0.014	54.4	7	40.3	387	1.1	1.0	66.3	1.8	272	40
Chad	0.007	55.2	11	22.6	810	2.9	0.4	95.7	1.9	387	50
Chile	1.074	80.7	23	87.8	15070	4.9	2.1	22	162	1275	823
China	0.003	77.5	144	57.3	8643	2.3	3.8	56.3	118	1046	543
Colombia	0.882	77.9	43	76,7	6273	4.5	1.7	17.1	64	1268	623
Comoros	0.016	65.0	444	28.4	788	4.3	2.2	19.1	1	549	79
Congo	0.019	645.2	15	65.8	1858	6.2	1.6	55.8	4	961	81
Congo DR.	0.007	61.6	37	43.0	478	2.3	0.8	56.3	2	434	62
Costa Rica	0.488	80.9	97	77.7	11685	7.1	1.2	18.5	175	1802	716
Croatia	0.957	79.0	74	59.3	13138	4.6	5.5	19.8	365	1030	671
Czechia	1.130	79.9	135	73	20152	4	6.8	19.2	502	572	1190
Cuba	0.013	78.2	102	67.9	7815	12.8	4.1	17	21	402	430
Cyprus	0.106	81.5	145	67.5	24976	6.1	3.4	17.9	595	1385	807
Denmark	0.239	81.4	135	87.9	56444	7.6	2.2	10.3	419	1217	971
Dominica	0.000	76.0	98	69.8	7291	3.4	3.8	19.9	nr	1067	670
Dominican R.[c]	0.240	74.7	209	79.8	7375	3.7	1.7	23.7	109	814	639
Ecuador	0.838	77.7	65	63.7	6098	5.0	1.6	13.2	48	835	573
Egypt	0.082	72.5	94	42.4	2501	3.8	0.5	126	44.4	1054	450
El Salvador	0.205	74.1	313	60.2	4400	3.5	1.1	33.4	17	1565	290
Ecuat.Guinea[d]	0.045	58,9	44	40.1	12727	0.6	2.1	71.2	3	471	238
Eritrea	0.001	67.5	44	22.6	980	2	0.7	50.5	6	102	12
Estonia	0.185	79.2	29	68.4	4491	7.1	2.1	5.9	515	1454	881
Ethiopia	0.016	67.8	96	19.9	873	4.5	6.3	49.7	1	597	154
Fiji	0.002	67.9	48	55.9	5740	3.9	2.1	7.7	106	1142	465
Finland	0.103	82.5	16	84.4	46017	7.2	4.0	6.0	608	1323	875
France	0.988	83.1	120	79.8	39869	5.5	6.0	12	496	1062	805
Gabon	0.032	67.0	7	87.4	7972	2.7	6.3	47.4	17	1315	481
Gambia	0.061	63.3	181	60.2	480	2.8	1.1	95	5	1392	185
Georgia	0.700	74.2	65	57.2	4099	3.8	3.1	20.7	220	1465	605
Germany	0.424	81.9	231	75.5	44550	4.9	8.1	13.5	548	1291	844
Ghana	0.011	64.9	121	54.7	1663	6.2	0.9	54.2	20	1275	347
Greece	0.455	82.8	81	78.3	18637	4.4	4.2	11.3	480	1159	6.1
Grenada	0.009	72.6	312	35.6	10360	10.3	3.5	18.5	156	1050	557
Guatemala	0.288	70.1	155	52	4472	2.8	0.6	28.5	41	1182	354
Guinea	0.007	62.6	48	35.3	749	2.4	0.3	46	0.4	871	98
Guinea Bissau	0.029	59.4	43	50.1	794	2.1	1.0	59.2	7	771	38
Guyana	0.202	70.3	4	28.7	4710	3.2	2.5	19.7	85	827	357
Haiti	0.022	65.0	401	59.8	784	1.4	1.3	23.5	4	591	122
Honduras	0.356	75.9	79	54.4	2766	5.9	0.8	29.5	34	889	300
Hungary	1.001	77.3	105	71.7	15331	4.6	7.0	24.6	337	768	1475

Iceland	0.000	83.5	3	94.2	70332	7.8	3.1	7.3	688	1126	982
India	0.113	70.4	403	33.1	1983	3.8	0.5	75.8	20	873	295
Indonesia	0.086	72.3	137	54.5	3876	3.6	0.9	16.7	53	1738	323
Iran	0.694	77.3	49	74	5305	3.4	0.1	49	150	1073	604
Iraq	0.399	71.1	86	69.6	5088	2.6	1.1	73.3	46	871	494
Ireland	0.489	82.8	68	63.5	23909	7.8	3.1	7.3	688	1226	982
Israel	0.385	83.5	422	92.2	40258	5.7	3.0	18.7	310	1267	816
Italy	1.233	84.0	200	69.1	31984	4.1	3.2	15.5	625	816	613
Jamaica	0.111	74.5	248	55	5048	5.4	1.7	15.1	54	1096	444
Japan	0.028	85.0	335	93.9	38440	3.6	13.1	13	311	1335	909
Jordan	0.386	75.0	113	90.3	5768	3.9	1.4	37.2	140	1038	623
Kazakhstan	0.157	73.9	7	57.4	8841	3.0	6.0	19.7	230	1454	764
Kenya	0.037	67.5	75	26.1	1702	5.3	1.4	16.3	19	682	166
Korea South	0.019	83.5	511	82.6	29891	5.1	12.0	28.7	327	1249	951
Kosovo	0.729	70.0	164	38	3811	nr	2.1	nr	156	258	nr
Kuwait	0.216	75.9	243	98.4	27319	3.8	1.8	111	394	1242	980
Kyrgyzstan	0.217	72.0	31	35.9	1144	6.0	4.5	17.9	149	1219	345
Laos	0.000	68.9	29	39.7	2542	2.9	1.1	27.7	11	541	219
Latvia	0.334	75.7	30	68.5	15547	5.3	5.7	337	32.6	813	814
Lebanon	0.275	79.3	514	87.9	11409	2.5	3.5	32.6	119	814	761
Lesotho	0.025	55.7	66	34.2	1425	13	1.3	26.9	6.3	1066	274
Liberia	0.018	65.0	41	50.1	729	2.8	0.8	17.3	4.5	676	73
Libya	0.236	73.4	4	78.8	4589	2.7	3.7	63.7	346	1217	203
Liechtenstein	1.158	81.8	231	14.3	152933	2.6	1.6	30.2	767	1043	952
Lithuania	0.660	76.4	43	67.1	16730	4.5	6.7	16.7	450	1509	776
Luxembourg	0.915	82.8	233	90.4	105803	4.0	4.6	16.1	678	1361	978
Madagascar	0.011	68.2	42	35.7	448	2.1	0.2	21.5	8.2	341	98
Malawi	0.014	65.5	147	16.5	324	4.7	1.3	28.3	4	417	115
Malaysia	0.015	76.7	97	75.4	9813	4.8	1.9	17.6	370	1339	801
Malta	0.515	83.1	1460	95.5	27250	7.2	4.7	12.1	615	1300	801
Mauritania	0.092	65.6	4	60.4	1318	2.6	0.4	123.6	5.5	922	180
Mauritius	0.008	75.5	618	39.5	9794	5.1	3.6	14.5	144	1454	522
Mexico	1.023	75.4	63	79.5	9304	5.3	1.5	18.8	220	885	639
Moldova	0.979	72.3	99	38.2	2280	6.7	5.3	19.9	177	904	710
Monaco	0.103	85.4	18867	100	168004	1.4	13.8	nr	737	852	952
Mongolia	0.000	70.5	2	72.8	3640	5.2	6.8	29.7	112	1264	223
Montenegro	1.130	77.3	45	64.2	7647	3.9	3.9	20	280	1661	713
Morocco	0.217	77.4	78	60.7	3151	6.3	0.8	25.4	75	1229	618
Mozambique	0.004	62.1	36	32.1	429	6.5	0.8	21	17.1	400	175
Myanmar	0.051	67.8	78	34.7	1264	2.2	0.9	48.8	10.1	899	251
Namibia	0.090	64.9	3	47.3	5413	8.3	2.7	25.9	42	1045	310
Nepal	0.065	71.7	197	19	834	3.7	0.3	78.5	5.2	1232	197
Netherlands	0.686	82.8	411	91	48346	5.5	3.6	15.2	484	1205	932
New Zealand	0.005	82.8	18	86.3	41593	6.3	2.7	5.5	553	1360	885
Nicaragua	0.012	75.2	49	58.2	2207	2.8	0.9	23	1316	1316	246
Niger	0.005	63.6	16	16.3	440	6.0	0.3	203.7	8.3	409	102
Nigeria	0.007	55.8	209	48.6	1994	0.7	0.5	122.5	6.3	759	257
North Maced.[e]	1.215	76.3	81	57.2	5474	3.4	4.4	32	180	1019	722
Norway	0.084	82.9	16	80.7	74941	7.7	3.7	8	505	1078	965
Oman	0.010	78.6	15	78.1	17973	6.2	1.6	78	172	1498	769
Pakistan	0.049	67.8	261	36.4	1541	2.8	0.6	75.8	13	734	155
Panama	1.007	79.1	54	66.9	15089	3.2	2.2	14.1	127	1459	540
Papua New G.[e]	0.001	65.2	17	13	2861	nr	4.0	13.7	8.2	468	96

Paraguay	0.325	74.6	17	13	4260	4.0	1.1	23.7	57	1097	611
Peru	1.208	77.7	24	78.9	6762	3.8	1.5	26.1	48	1210	487
Philippines	0.090	71.7	344	44.3	2976	2.7	0.97	23.3	12.2	1104	555
Poland	0.750	79.3	123	60.2	13823	4.9	6.6	26	564	1305	760
Portugal	0.685	82.7	112	64	21161	5.1	3.4	9.5	453	1139	738
Qatar	0.095	80.7	222	99.3	60804	3.6	1.2	148.2	114	1483	943
Romania	0.793	76.5	82	53.6	10757	3.1	6.8	19.1	277	1146	638
Russian Fed. [f]	0.403	73.0	9	74.3	10608	3.8	8.2	15.5	285	1579	760
Rwanda	0.009	70.0	448	25.8	772	3.5	1.7	53	4.3	722	200
Saint K. and N.[g]	0.000	75.1	202	32.2	16296	2.8	2.3	nr	153	1389	768
San Marino	1.830	85.1	545	94.2	47406	2.4	3.8	nr	1095	1138	508
Santa Lucia	0.028	76.7	289	18.5	9607	5.7	1.1	17.3	157	988	467
Saint Vin. Gren.[h]	0.000	73.0	282	50.9	7271	5.8	2.2	17.4	145	1057	656
Sao Tome P.[i]	0.085	66.2	200	65.6	1785	3.7	2.9	15.4	30	950	280
Saudi Arabia	0.192	75.7	15	83.3	21120	5.6	2.2	187.9	132	1221	801
Senegal	0.027	68.9	78	44.1	1038	7.1	0.3	56.8	16.4	994	257
Serbia	0.649	76.3	91	55.7	5899	4.0	5.6	18.8	258	1241	703
Seychelles	0.000	73.7	210	54.2	15686	3.6	3.3	14.8	141	1766	565
Sierra Leone	0.010	55.9	100	40.3	491	2.9	0.4	42.1	5.2	849	118
Singapore	0.008	80.1	5509	100	57713	2.9	3.5	25	155	1482	844
Slovakia	0.415	78.0	102	53.8	23654	5.3	4.5	17.8	531	1174.6	789
Slovenia	1.482	81.6	102	49.6	23564	5.3	4.5	17.8	531	1175	789
Somalia	0.009	58.3	22	40	92	nr	0.8	23.9	1.8	465	19
South Africa	0.525	64.9	46	65.3	6180	5.9	2.3	35.9	116	1620	540
Spain	1.170	84.0	92	64.2	28359	4.3	3.0	10	439	1132	846
Sri Lanka	0.010	77.6	327	18.4	4085	1.6	3.7	25.6	27.4	1351	846
Sudan	0.039	66.1	22	34	1428	2.2	0.8	77.7	1.3	707	280
Suriname	0.220	72.1	3	66	5746	6.7	3.1	21.5	148	1413	545
Sweden	1.066	83.3	23	86	53218	7.7	2.3	5.2	473	1255	964
Swaziland	0.206	61.1	63	21.3	3915	7.1	2.1	24.2	39.4	741	286
Switzerland	0.924	84.3	205	74	80591	5.1	4.5	10.5	535	1332	937
Syria	0.304	76.1	115	58.1	1203	5.5	1.5	43.5	35.5	857	319
Tajikistan	0.010	71.8	61	26.3	824	5.2	4.6	61.4	39.3	1076	205
Tanzania	0.000	66.4	55	32.3	1034	3.5	1.1	22.3	0.5	697	130
Thailand	0.001	77.7	132	51.5	6591	4.1	2.1	23.2	109	1760	529
Timor Leste	0.000	70.2	82	33.4	2104	7.5	5.9	17	9	1193	252
Togo	0.009	62.1	134	40.5	611	5.1	0.7	84.1	19.2	798	1234
Trinidad Tobago	0.094	79.3	265	8.4	15769	4.2	2.7	16.8	259	1483	733
Tunisia	0.416	77.4	676	70	3469	6.6	1.8	35.6	89	1243	555
Turkey	0.265	78.5	104	73.9	10512	4.4	2.7	37.3	142	968	647
Uganda	0.007	64.4	156	21.4	699	2.3	0.5	73.5	4.2	582	219
Ukraine	0.455	72.4	73	69.2	2583	5.9	7.8	19.2	171	1335	530
Un. Arab. Emir. [m]	0.115	78.5	73	85.8	37226	1.0	2.1	105,1	346	2109	948
United Kingdom	1.152	81.8	272	82.8	39735	5.6	2.6	11.5	475	1196	948
United States	1.060	79.1	35	81.8	59501	5.0	2.8	9.2	357	1220	762
Uruguay	0.055	78.4	20	95.5	16722	4.4	2.5	11.5	216	1475	664
Uzbekistan	0.020	72.0	72	50.6	1491	7.7	4.4	46.7	36.5	760	468
Venezuela	0.033	72.3	34	89	6684	6.9	0.9	26.3	114	766	600
Vietnam	0.000	75.8	280	34.5	2354	5.7	2.7	26.3	2	1256	465

Yemen	0.022	66.4	52	35.2	551	5.2	0.7	72.6	22.4	596	246
Zambia	0.024	64.7	22	41.4	1480	0.8	2.0	30.6	16	786	255
Zimbabwe	0.026	62.2	38	32.3	1176	8.4	3.9	24.5	57.3	826	213
176 countries											
r *Vs* COVID-19		-0.025	-0.051	0.383	0.304	-0.008	0.306	-0.221	0.584	0.203	0.533
p		>0.05	>0.05	<0.01	<0.01	>0.05	<0.001	<0.01	<0.01	<0.01	<0.01

a Antigua Bar: Antigua Barbuda; b Cent. Afr. R.: Central African Republic; c Dominica R.: Dominican Republic; d Ecuat. Guinea: Ecuatorial Guinea; e North Maced.: North Macedonia; g Russian Fed.: Russian Federation; f Papua New G.: Papua New Guinea; h Saint K and N.: Sain Kitts and Nevis; i Saint Vin. Gren.: Saint Vincent and Grenadines; L Sao Tome P.: Sao Tome and Principe; L Un. Arab. Emir.: United Arab Emirates; n COVID- 19: deaths × 10^3; o LE: life expectancy in years; p PD: population density as inhabitants/Km^2; q UP: urban population%; r GDP: Gross domestic product in USD; s ED: education expenses as % of GDP; t HB: Hospital beds × 10^3 inhabitants; u PM: particulate matter 2.5-10 μ in mg/m^3; v CA: cars × 10^3 inhabitants; v MP: mobile phones × 10^3 inhabitants; w IN: internet × 10^3 inhabitants

Table 3: Vaccine shots per 10^3 inhabitants administered up to 30 March.

Country	Vaccine 10^3	Country	Vaccine 10^3	Country	Vaccine 10^3	Country	Vaccine 10^3
Afganistan	1.13	Denmark	187.30	Laos	2.53	Rwanda	29.72
Albania	8.51	Dominica	213.98	Latvia	63.07	Saint K. and N.	148.37
Algeria	0	Dominican R.	76.40	Lebanon	34.23	San Marino	237.34
Andorra	122.53	Ecuador	11.40	Lesotho	7.88	Santa Lucia	117.61
Angola	3.80	Egypt	0.01	Liberia	0	Saint Vin. Gren.	84.64
Antigua Barb.	257.52	El Salvador	9.97	Libya	0	Sao Tome P.	53.64
Argentina	76.42	Ecuat. Guinea	4.82	Liechtenstein	147.35	Saudi Arabia	109.21
Armenia	0	Eritrea	0	Lithuania	152.97	Senegal	19.31
Australia	24.19	Estonia	193.62	Luxembourg	163.13	Serbia	34.85
Austria	184.44	Ethiopia	0	Madagascar	0	Seychelles	984.88
Azerbaijan	26.00	Fiji	0	Malawi	6.43	Sierra Leone	2.35
Bahamas	0.28	Finland	179.29	Malaysia	12.47	Singapore	332.57
Bahrein	530.58	France	163.54	Malta	369.62	Slovakia	173.07
Bangladesh	32.08	Gabon	0.27	Mauritania	0	Slovenia	165.99
Barbados	220.23	Gambia	3.35	Mauritius	106.95	Somalia	0.89
Belgium	158.97	Georgia	1.31	Mexico	50.55	South Africa	3.24
Belize	47.49	Germany	158.30	Moldova	12.11	Spain	163.40
Benin	0	Ghana	18.04	Mongolia	32.05	Sri Lanka	40.56
Belarus	9.49	Greece	148.17	Monaco	258.49	Sudan	0.01
Bolivia	22.73	Grenada	107.22	Montenegro	38.23	Suriname	33.31
Bosnia	0	Guatemala	4.91	Morocco	222.24	Sweden	162.88
Botswana	0	Guinea	4,15	Mozambique	2.43	Swaziland	2.95
Brazil	79.71	Guinea Bissau	0	Myanmar	1.99	Switzerland	173.78
Brunei	0	Guyana	30.44	Namibia	0.06	Syria	0
Bulgaria	63.65	Haiti	0	Nepal	60.67	TaJikistan	0
Burkina Faso	0	Honduras	5.99	Netherlands	141.33	Tanzania	0
Burundi	0	Hungary	263.57	New Zealand	8.66	Thailand	1.78
Cambodia	25.36	Iceland	189.65	Nicaragua	0	Timor Leste	0
Cameroon	0	India	41.28	Niger	0	Togo	5.16
Canada	128.53	Indonesia	37.21	Nigeria	3.30	Trinidad Tobago	0.84
Cabo Verde	5.06	Iran	2.51	North Maced.	4.77	Tunisia	3.87
Centr. Afr.R.	0	Iraq	0.58	Norway	166.38	Turkey	195.95
Chad	0	Ireland	176.77	Oman	30.02	Uganda	1.33
Chile	603.82	Israel	1123.94	Pakistan	3.17	Ukraina	5.88
China	82.95	Italy	152.52	Panama	75.97	Un. Arab. Emir.	1353.78

Colombia	29.95	Jamaica	12.33	Papua New G.	0	United Kingdom	542.04
Comoros	0	Japan	0.37	Paraguay	2.63	United States	416.14
Congo	0.05	Jordan	36.44	Peru	25.13	Uruguay	137.33
Congo D.R.	0	Kazakhstan	14.17	Philippines	2.83	Uzbekistan	0
Costa Rica	77.38	Kenia	0.20	Poland	155.20	Venezuela	0
Croatia	109.16	Korea South	16.79	Portugal	164.55	Vietnam	0.02
Czechia	148.35	Kossovo	0	Qatar	306.38	Yemen	0
Cuba	0	Kuwait	115.47	Romania	146.33	Zambia	0
Cyprus	120.64	Kyrgyzstan	0	Russian Fed.	77.47	Zimbawe	2.99

Table 4: Differences of deaths × 10^3 (DJM) of the period between January 4/22 and March 8/29.

Country	DMJ		Country	DMJ		Country	DMJ		Country	DMJ	
Afganistan	0.441		Denmark	12.272		Laos	0		Rwanda	0.432	
Albania	-5.540	↑	Dominica	0		Latvia	13.793		Saint K. and N.	0	
Algeria	0.000		Dominican R.	0.576		Lebanon	3.520		San Marino	-6.061	↑
Andorra	15.000		Ecuador	-0.584	↑	Lesotho	5.082		Santa Lucia	-5.618	↑
Angola	0.099		Egypt	0.372		Liberia	0.022		Saint Vin. Gren.	0	
Antigua Barb.	-5.941	↑	El Salvador	2.066		Libya	-1.478	↑	Sao Tome P.	-2.000	↑
Argentina	2.958		Ecuat. Guinea	-0.364	↑	Liechtenstein	18.919		Saudi Arabia	-1.014	↑
Armenia	0		Eritrea	0.089		Lithuania	20.116		Senegal	0.328	
Australia	0		Estonia	-8.587	↑	Luxembourg	-3.091	↑	Serbia	-2.369	↑
Austria	9.238		Ethiopia	-0.360	↑	Madagascar	-5.301	↑	Seychelles	-5.208	↑
Azerbaijian	0.398		Fiji	0		Malawi	2.262		Sierra Leone	0.041	
Bahamas	-0.256	↑	Finland	0.567		Malaysia	-0.015	↑	Singapore	0	
Bahrein	-2.879	↑	France	4.725		Malta	-5.176	↑	Slovakia	2.324	
Bangladesh	-0.156	↑	Gabon	-1.263	↑	Mauritania	1.401		Slovenia	28.163	
Barbados	0		Gambia	-0.041	↑	Mauritius	-0158	↑	Somalia	-1.760	↑
Belgium	5.686		Georgia	9.145		Mexico	12.774		South Africa	21.201	
Belize	12.887		Germany	21.789		Moldova	-22.582	↑	Spain	18.082	
Benin	0		Ghana	-0.148	↑	Mongolia	-0.160	↑	Sri Lanka	0.093	
Belarus	0.200		Greece	-6.827	↑	Monaco	0.020		Sudan	0.142	
Bolivia	4.701		Grenada	0		Montenegro	-19.672	↑	Suriname	5.197	
Bosnia	-25.026	↑	Guatemala	2.499		Morocco	1.868		Sweden	19.273	
Botswana	0		Guinea	-0.252	↑	Mozambique	0,506		Swaziland	29.438	
Brazil	-18.386	↑	Guinea Bissau	-0.102	↑	Myanmar	0.771		Switzerland	13.719	
Brunei	0		Guyana	-2.070	↑	Namibia	1.815		Syria	-0.025	↑
Bulgaria	-21.857	↑	Haiti	0.065		Nepal	0.466		TaJikistan	0	
Burkina Faso	0.138		Honduras	0.451		Netherlands	9.507		Tanzania	0	
Burundi	-0.027	↑	Hungary	-30.282	↑	New Zealand	0		Thailand	0.004	
Cambodia	-0.120	↑	Iceland	0		Nicaragua	0		Timor Leste	0	
Cameroon	-0.949	↑	India	-0.153	↑	Niger	0.276		Togo	-0.145	↑
Canada	8.703		Indonesia	1.178		Nigeria	0.941		Trinidad Tobago	0.074	

Cabo Verde	0.186		Iran	0.058		North Maced.	-16.819	↑	Tunisia	10.056	
Centr. Af. R.	-0.196	↑	Iraq	-2.081	↑	Norway	1.665		Turkey	1.803	
Chad	-0.069	↑	Ireland	16.139		Oman	-1.535	↑	Uganda	0.130	
Chile	-5.124	↑	Israel	10.877		Pakistan	-7.989	↑	Ukraina	-8.171	↑
China	0.002		Italy	3.566		Panama	23.235		Uni. Arab. Emir	-0.889	↑
Colombia	12.805		Jamaica	-4.471	↑	Papua New G.	-0.557	↑	United Kingdom	44.349	
Comoros	9.190		Japan	0.878		Paraguay	-0.841	↑	United States	17.342	
Congo	0.234		Jordan	-17.935	↑	Peru	-6.012	↑	Uruguay	-4.943	↑
Congo D.R.	0.055		Kazakhstan	-0.782	↑	Philippines	0.443		Uzbekistan	-0.009	↑
Costa Rica	6.382		Kenia	-0.571	↑	Poland	-4.029	↑	Venezuela	-0.347	↑
Croatia	14.443		Korea South	0.662		Portugal	46.479		Vietnam	0	
Czechia	-8.011	↑	Kosovo	-6.249	↑	Qatar	-1.395	↑	Yemen	7.968	
Cuba	-0.178	↑	Kuwait	-4.550	↑	Romania	-3.880	↑	Zambia	1.458	
Cyprus	3.202		Kyrgyzstan	0.288		Russian Fed.	2.195		Zimbawe	5.257	

↑: increase of deaths; DJM: difference between the weeks of 4/25 January and 8/29 March

Comparing the two periods, 66 of the 176 countries (37%) show an increase in death rate, and 48 of these countries were among those which started the vaccination program. The correlation between the differences in number of deaths between the two periods and the numbers of vaccine doses is not statistically significant (ρ =0.0708 $p > 0.05$). A few examples of trends in number of deaths during the period from 4 January to 29 March are shown in countries with different vaccine coverages: high, none, and less than 20%.

Countries with the highest vaccine coverage

United Arab Emirates (1353.38 × 10^3 inhabitants - Figure 6); Israel (1123.94 per 10^3 inhabitants - Figure 3); the UK (542.04 per 10^3 inhabitans - Figure 4); and the USA (416.1 per 10^3 inhabitants - Figure 5).

A clear decrease in the number of deaths was seen in all these countries. In the USA, values stabilized or slightly increased after the initial decrease. This may be due to a loosening of the lockdown restrictions in some parts of the country causing the viral spread to increase again.

Countries without any vaccine coverage

On 30 March, thirty-six countries were not using vaccines. The reasons are unknown and figure shows the trend in all of these countries taken together (Figure 6).

Tables 3-5 list the 36 countries. Seven of these countries, Bosnia (Figure 11), Kosovo (Figure 12), Botswana, Armenia, Libya, Comoros and Zambia accounted for over 85% of the deaths in the period . The other countries had totals amounting to less than 5 per 10^5 deaths. The LEEDELS data for these 36 countries were compared to those of the other countries (139) to determine any differences (Table 6).

The differences are significant for all variables, apart from the percentage of land covered by forests. The correlations between the LEEDELS data and COVID-19 death rates were calculated for the two sets of countries and the results are shown (Table 6).

The pattern of correlations with number of COVID-19 deaths is different in the two sets of countries. The only identical positive correlations regard cars and internet connections, which can be considered as indicators of general economic prosperity.

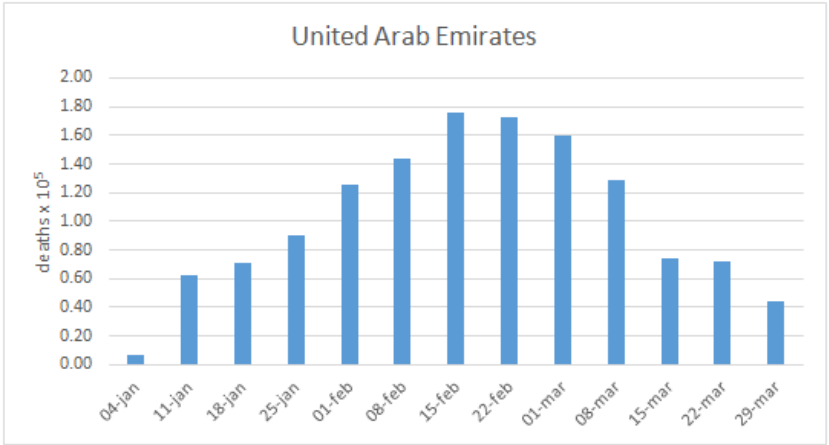

Figure 6: Trend in number of deaths in the United Arab Emirates during the period immediately after the start of vaccinations up to 29 March 2021: weekly number of deaths per 10^5.

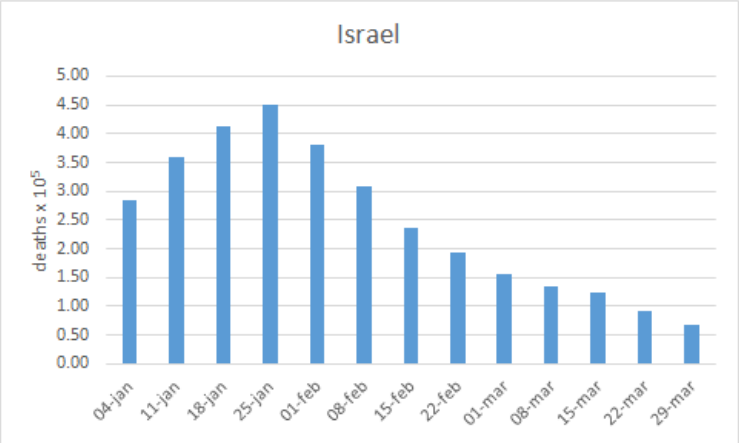

Figure 7: Trend in number of deaths in Israel during the period immediately after the start of vaccinations up to 29 March 2021: weekly number of deaths per 10^5.

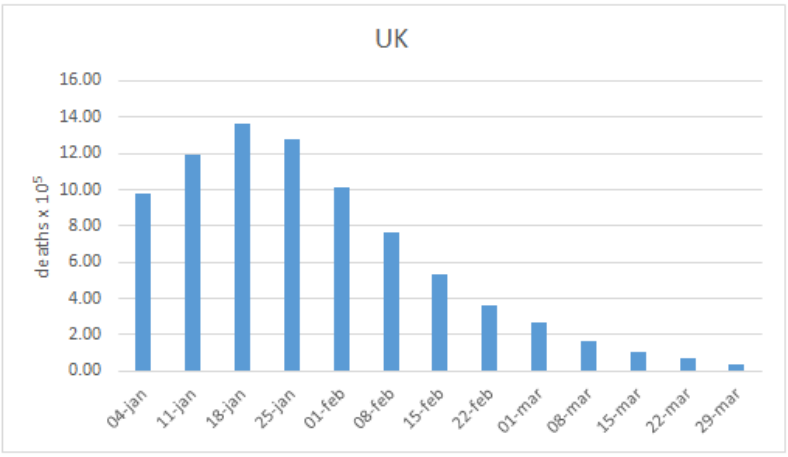

Figure 8: Trend in number of deaths in the UK during the period immediately after the start of vaccinations up to 29 March 2021: weekly number of deaths per 10^5.

Table 5: Comparison between the LEEDELS data for the 36 countries without vaccine programmes and the 140 countries carrying out a vaccination campaign.

Variable	Unit	36 countries with no vaccine	140 countries with vaccine	P a
Life expectancy	Years	67.9 ± 6.15	75.1 ± 11.23	<0.05
>65 years per 10^3	N	690.1 ± 901.95	3812.5 ± 9865.80	<0.05
65 years/others	ratio	9.8 ± 6.15	22.9 ± 55.78	<0.05
>65 years	%	4.6 ± 3.30	10.0 ± 6.82	<0.05
Population Density	inhabitants/Km^2	82.6 ± 108.12	204.7 ± 510.54	<0.05
Urban population	% of inhabitants	44.8 ± 19.19	61.6 ± 22.87	<0.05
GDP	USD/inhabitant	4624 ± 11769.8	18545 ±25896.7	<0.05
Education	% GDP	4.3 ± 2.53	4.6 ± 1.88	<0.05
Hospital beds	N/10^3 inhabitants	2.1 ± 1.70	3.1 ± 2.49	<0.05
PM 2.5-10.0	mg/m^3	50.7 ± 42.69	34.9 ± 39.90	<0.05
Cars	N/10^3 inhabitants	54.4 ± 84.95	231.3 ± 227.44	<0.05
Mobile phones	N/10^3 inhabitants	773.7 ± 341.95	1134.7 ± 311.57	<0.05
Internet	Connections/10^3 inhabitants	253.6 ± 214.10	611.2 ± 285.13	<0.05
Forests	Percentage of land	27.7 ± 23.65	32.0 ± 22.15	>0.05

a: Mann–Whitney U test p values

Table 6: Correlation between LEEDELS data and COVID-19 death rates up to 28 December 2020 in countries with and without vaccination programmes.

Variable	Unit	36 countries without vaccination Spearman's ρ	p	140 countries with vaccination Spearman's ρ	p
Life expectancy	Years	0.2898	>0.05	0.4691	<0.05
> 65 years x 10^3	ratio	-0.1447	>0.05	0.0741	>0.05
65 years/others	%	0.5289	<0.05	0.0742	>0.05
> 65 years	inhabitants/Km^2	0.1568	>0.05	0.4698	<0.05
Density	inhabitants/Km^2	0.0387	>0.05	-0.0867	>0.05
Urban population	% of inhabitants	0.2034	>0.05	0.3562	<0.05
GP total	USD/inhabitant	0.0071	>0.05	0.2646	<0 .05
Education	% total GDP	-0.1142	>0.05	0.0608	>0.05
Hospital beds	N/10^3 inhabitants	0.2258	>0.05	0.2082	<0.05
PM 2.5-10.0	mg/m^3	0.1049	>0.05	-0.2427	<0.05
Cars	N/10^3 inhabitants	0.3766	<0.05	0.5093	<0.05
Mobile phones	N/10^3 inhabitants	0.1280	>0.05	0.0646	>0.05
Internet	Connections/10^3 inhabitants	0.4129	<0.05	0.4027	<0.05
Forest	Percentage of land	-0.1112	>0.05	0.0502	>0.05

GDP, which is the most important wealth index, is positively correlated only in the countries which are implementing vaccine programmes. This may mean that only the countries with the most resources are able to procure vaccines, which are initially insufficient to cover the entire world demand.

We should underline one further aspect: the relationship between age and COVID-19. In the 36 countries with no vaccine programme, old age (represented by the 65 years/other variable, known as the elderly people "dependence") is positively correlated with COVID-19 deaths, meaning that these countries are not good places to be old in. However, the number of deaths in the old age category is more substantial in the other countries, because life expectancy is significantly higher.

Countries with vaccine coverage of under 200 per 10^3 inhabitants

Although the vaccination programmes started in January, a decrease was still not evident or was only temporary in most of these countries at the end of March. The data for Italy (152.52 × 10^3), Poland (155.2 × 10^3), and Brazil (79.91 × 10^3) are given as examples (Figures 13-15).

The trend in these countries may be due to the limited number of shots administered and more shots are probably needed to get closer to herd immunity, which may be calculated at around 60 % of the population of a given country [16]. This means it will take several more months to cover the whole population with vaccines.

The overall picture of the relationship between vaccine and pandemia

From the data of the countries with and without the vaccine program, tentatively is possible to define a model of the viral infections once the vaccine campaign will be completed. The examples were calculated using the data of four countries with the highest vaccine coverage at March 30: Israel, Chile, UK and USA, respectively characterized by 1124, 604, 542, and 416 doses × 10^3 inhabitants (Figures 16-19). The theoretical curves were calculated simply subtracting from the real weakly values of the periods, the value of the weak immediately before the starting of the vaccination program.

In the case of Israel the real deaths in the period between December 14 2020 and April 12 2021 was 3388 : the theoretical reduction was down to 2171 (36% reduction).

In the case of Chile the real deaths in the period between December 21 2020 and April 12 2021 were 8154 : the theoretical reduction was down to 4619 (52% reduction).

In the case of UK the real deaths in the period December 8 to April 12 were 63234 : the theoretical reduction was down to 26559 (58% reduction). In the case of USA the real deaths in the period between December 14 2020 and April 12 2021 were 262177 : the theoretical death reduction was down to 175021 (33% reduction). In general, the COVID-19 infection in most of the European countries was following 5 phases: In the Phase 1 the virus starts with one (or more) outbreak/s that in a short period of time (weeks) is causing its diffusion, which is represented by the Phase 2. In few weeks the deaths reach the peak which can be stabilized in the following Phase 3 representing the most aggressive phase of the viral infection and lasting one-two weeks. The phase 4 follows represented by the decay of the deaths which can last many weeks depending upon the severity of the phase 3. The phase 5 follows in which the number of deaths is flattening at the minimum level.

The vaccination program has the following effects: a) reducing the increase of deaths, but still there is an initial increasing phase up to the stabilization in the phase; b) 3, 4 and 5 shortened up to represent one decay phase only. At the end, half of the deaths can be expected but still the figures are too high, and the non-mortal drifts seems to be the only hope. A tentative model of the virus road map is reported (Figures 15-20).

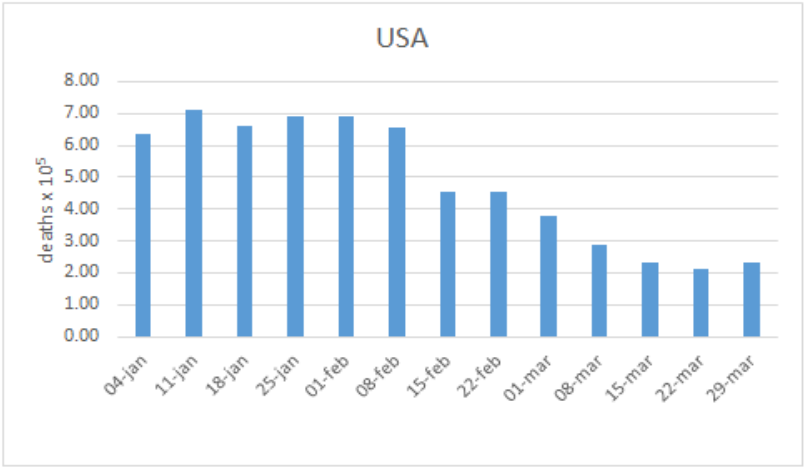

Figure 9: Trend in number of deaths in the USA during the period immediately after the start of vaccinations up to 29 March 2021: weekly number of deaths per 10^5.

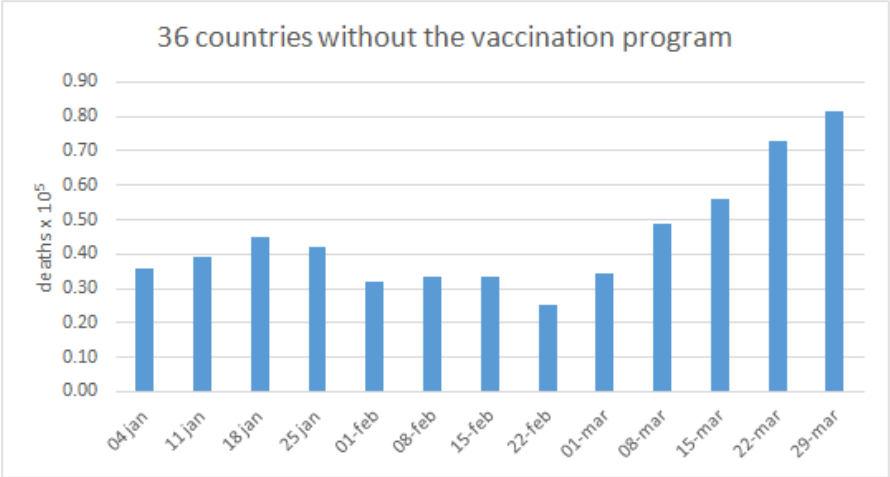

Figure 10: Trend in number of deaths in the 36 countries without any vaccine coverage as yet. Data during the period immediately after the start of the vaccination campaigns in other countries up to 29 March 2021: weekly number of deaths per 10^5.

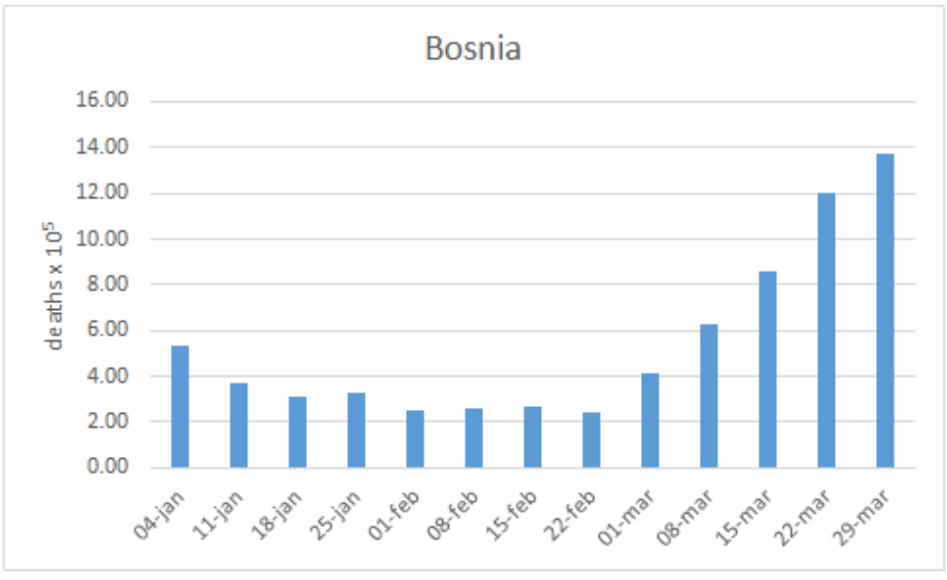

Figure 11: Trend in number of deaths in Bosnia during the period immediately after the start of vaccinations up to 29 March 2021: weekly number of deaths per 10^5.

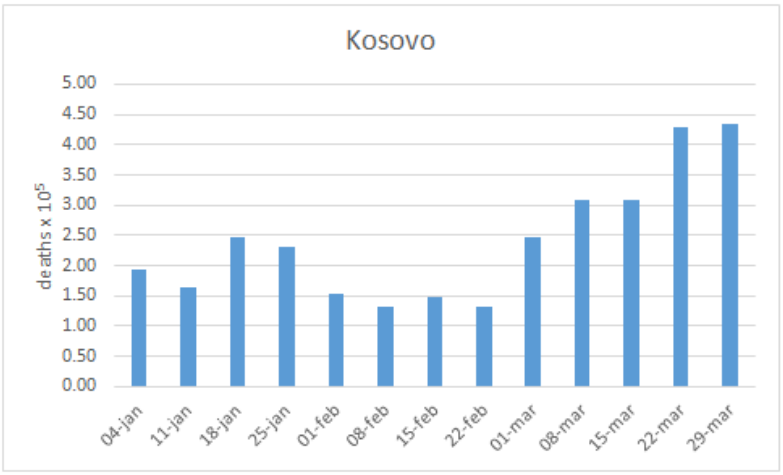

Figure 12: Trend in number of deaths in Kosovo during the period immediately after the start of vaccinations up to 29 March 2021: weekly number of deaths per 10^5.

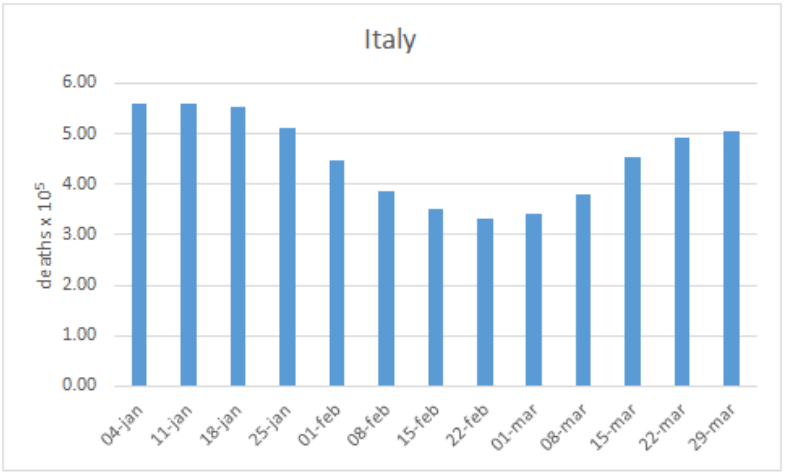

Figure 13: Trend in number of deaths in Italy during the period immediately after the start of vaccinations up to 29 March: weekly number of deaths per 10^5.

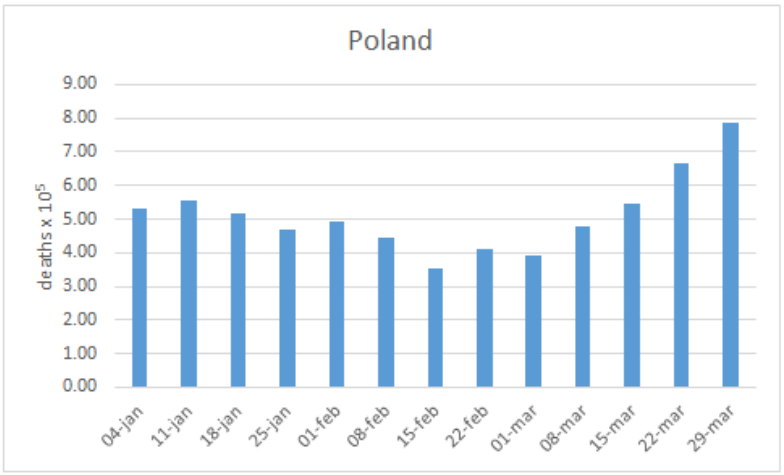

Figure 14: Trend in number of deaths in Poland during the period immediately after the start of vaccinations up to 29 March: weekly number of deaths per 10^5.

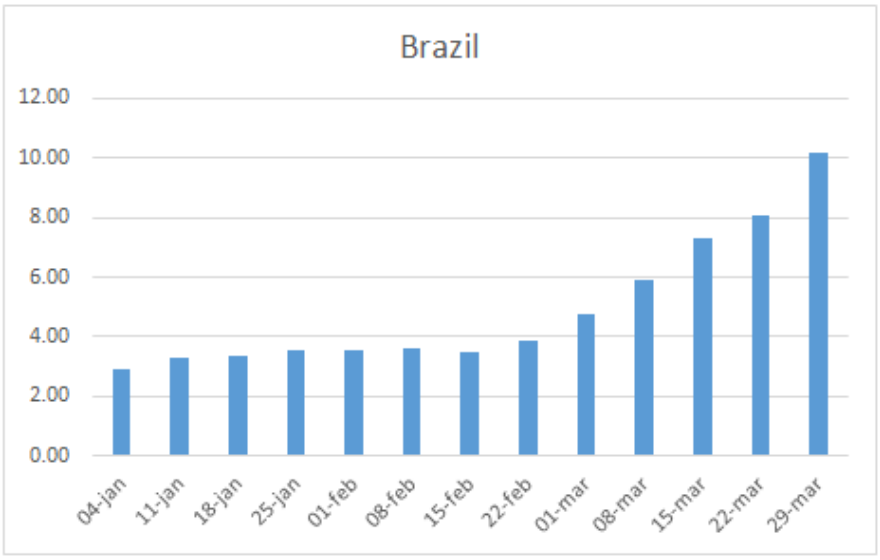

Figure 15: Trend in number of deaths in Brazil during the period immediately after the start of vaccinations up to 29 March: weekly number of deaths per 10^5.

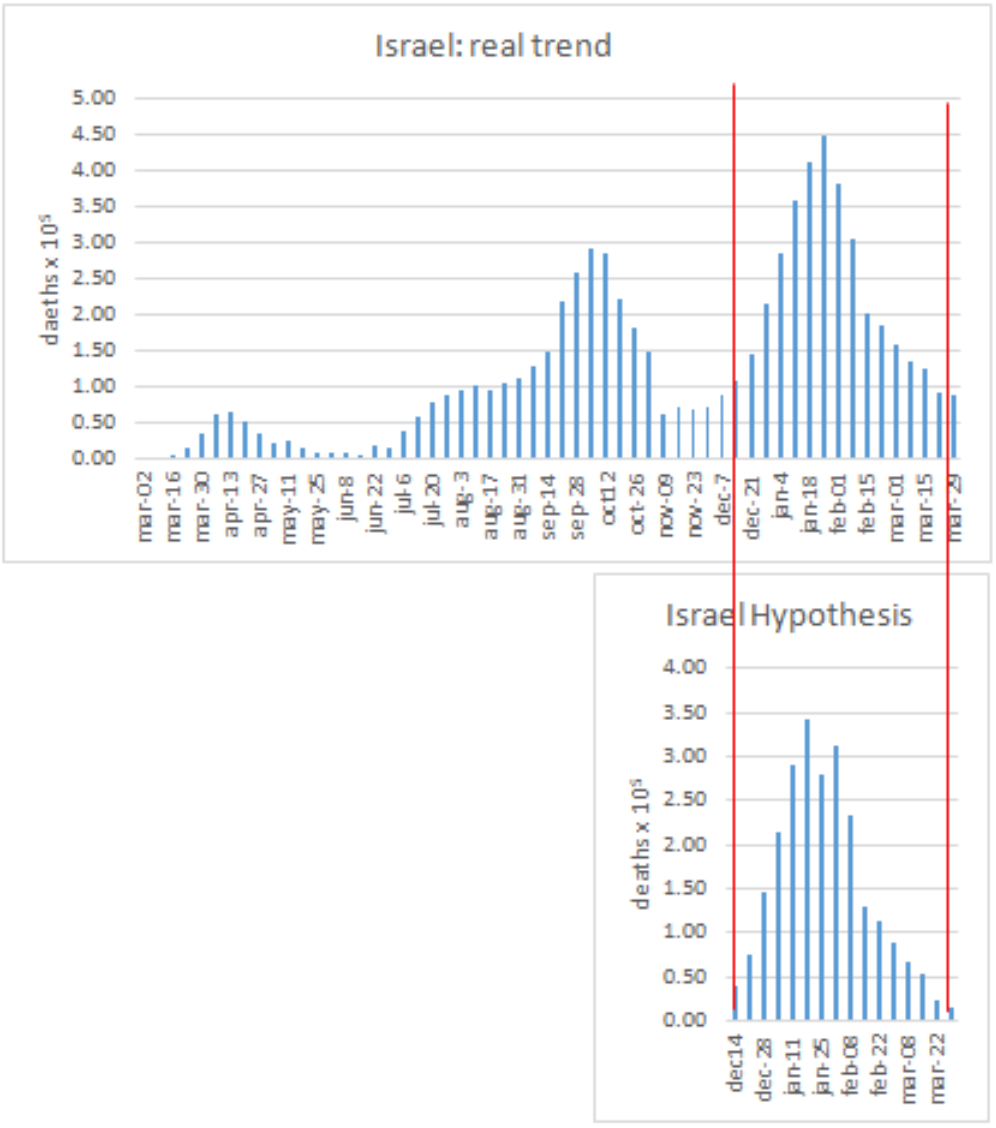

Figure 16: Trend of deaths in Israel: real values and theoretical trend following vaccinations.

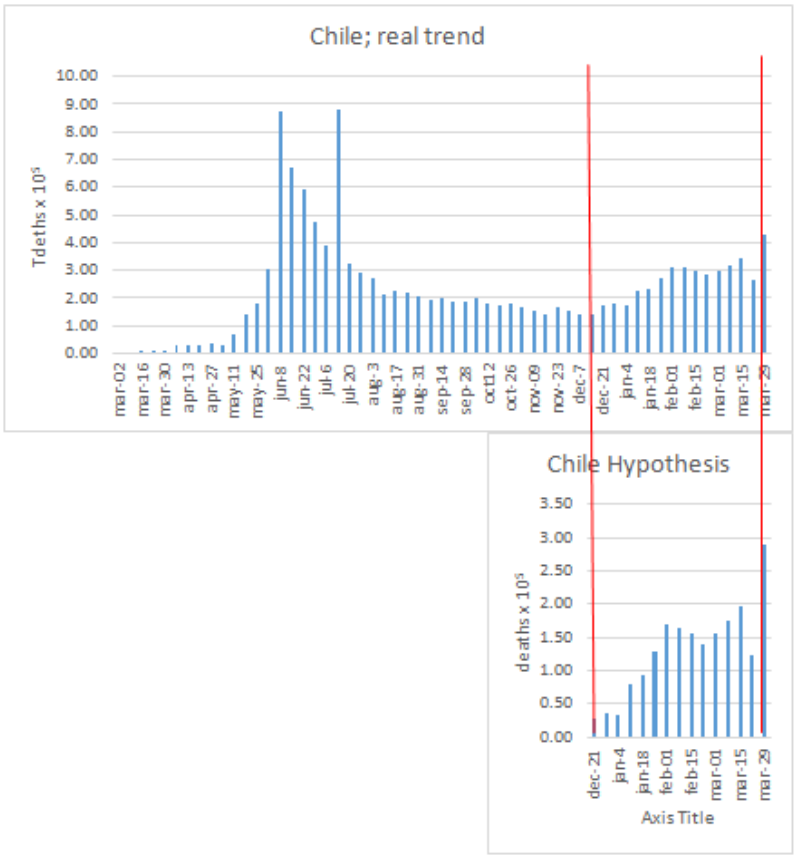

Figure 17: Trend of deaths in Chile: real values and theoretical trend following vaccinations.

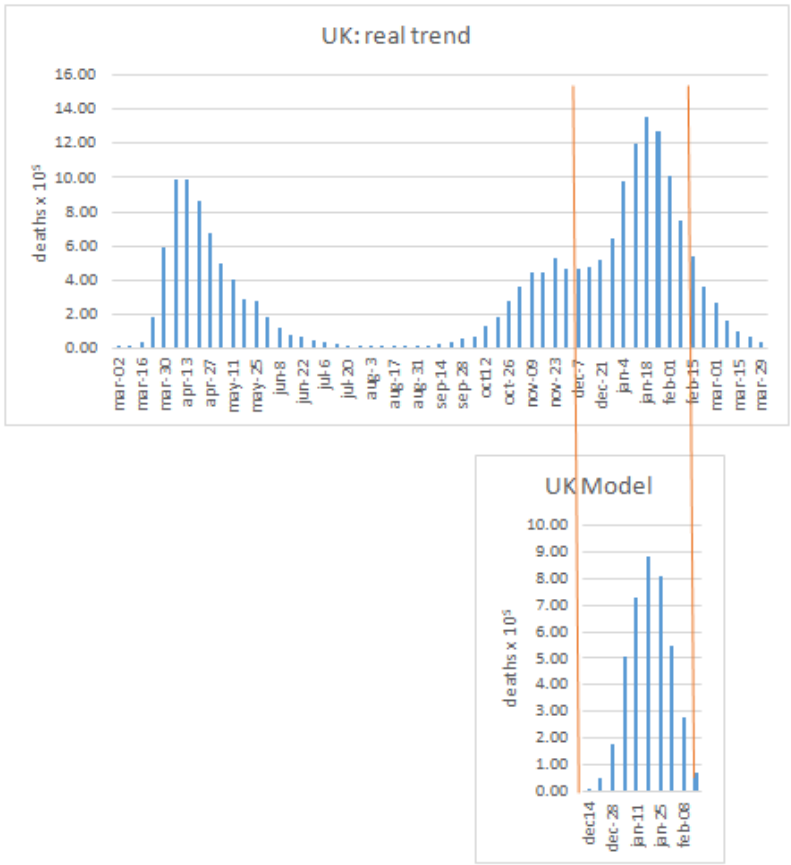

Figure 18: Trend of deaths in UK: real values and theoretical trend following vaccinations.

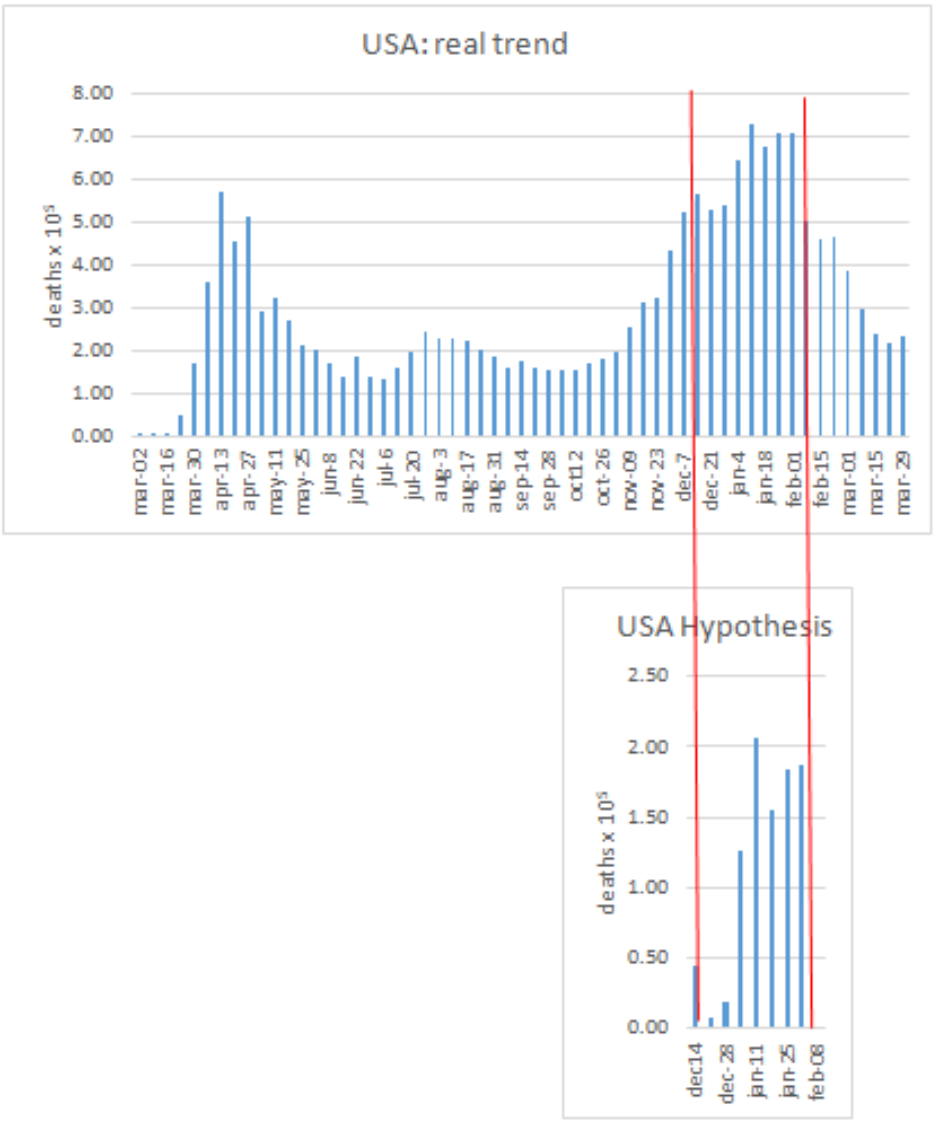

Figure 19: Trend of deaths in USA: real values and theoretical trend following vaccinations.

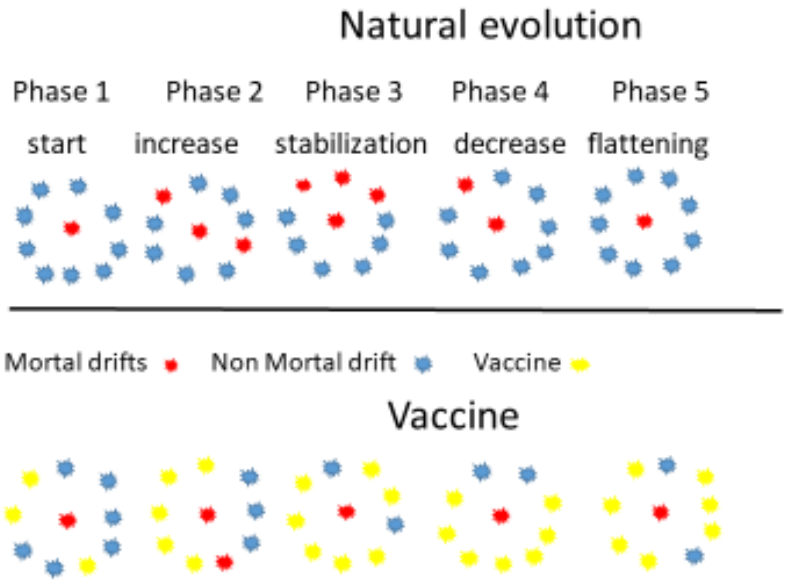

Figure 20: Natural selection of viral drifts during a wave.

Over time many outbreaks will occur and invade the environment, with the following consequences:

a) The process of viral drift is related to the number of infected cases.

b) More cases mean more drift which can initially give rise to more lethal variants, but also less lethal ones, until variants that cause infections without clinical symptoms occur.

c) However, viral transmission from the latter subjects to many other subjects can end up leading to some more lethal variants occurring again.

d) The latter cases may then again transform into less lethal variants.

e) The final result of this chain is a general trend towards a decrease in death rates, because this is the only way the virus can become part of our metaorganism.

f) The vaccines may not be effective on all variants, but they may provide some immunological defences that make the virus less lethal, thus reducing its replication and the amount of viral load in the patients that may spread it.

DISCUSSION

Limitations of this study

The main limitation of this study is that we have considered the deaths due to COVID-19 during the first four weeks of the vaccination campaign (from the week of 4 January to the week of 28 January) with those after ten weeks of vaccination (from 2 March to 29 March). This was done considering the overall death trend in the world, which reached its highest values in the period between 8 and 28 January and lowest levels in the period between 2 and 29 March 2021 .

The vaccination programme started in the first two weeks of December in the UK, Israel and the USA only. All the other countries (136) followed, during the first two weeks of January. The number of doses administered at March 30 was about 578 million. The number of people treated was different in each country, and there were countries with a high coverage (1353.78 per 10^3 inhabitants) and countries with a relatively low coverage (0.01 per 10^3 inhabitants). The complete coverage of a country is 2000 per 10^3 inhabitants because all the vaccines used at present need two shots. The only vaccine that could be administered only once, Ad.COV.S, was used in USA in <3% of the people.

None of the countries were in the conditions calculated for herd immunity [16]. Therefore, theoretically we cannot expect the vaccines to have a complete effect in any of the countries. At the moment, the only way to measure the real efficacy of the current vaccines is to compare the death trends of the countries concerned following the start of the vaccination programme with those before the vaccine was in use.

Another limitation is the diagnosis of death due to or with COVID-19. The WHO indicates which countries provide suitable and approved data for number of deaths, and these are limited to 49 countries only [17]. However, the pandemic has already lasted for more than one year and the deaths due to COVID-19 were supposed to be assessed in a similar way in all countries by now. As regards deaths due to or with the virus, we can assume that the infection is at least an important concomitant cause.

It was decided to use death rates (mortality) instead of the number of positive swabs (morbidity) owing to the possibility of bias, which was considered lower in the case of death rates. The total number of positive swabs also includes subjects who have been tested more than once and false positive/negative tests. Therefore, the risk of bias was considered much higher. Despite this, the correlation between number of positive swabs and number of deaths was seen to be extremely high [18].

The overall picture

The virus originated in China in 2019 and, unfortunately, due to globalization it spread around the world more or less like a commercial product. Many waves of COVID-19 have been recorded in the world since its appearance and it has caused a total of about 3 million deaths. The hope is that vaccinations will generate a suitable barrier against its spread.

Although 550 million shots of vaccine have been administered in the world (up to 30 March), it is evident from Figure 1 that the death rate is tending to grow again after an initial decrease. This means that vaccines alone may not be sufficient to stop deaths. Although herd immunity had not been reached in any country up to 30 March, the fact the death rate has started to grow again suggests that something else is needed to control this pandemic.

Furthermore, it is very hard to justify the number of deaths that will occur up to the moment when herd immunity is reached. Is the time needed to reach herd immunity an unavoidable price to pay or is it an excuse to cover up serious shortcomings in health planning? The presence of different waves in the period between 2019 and 2021 is typical of many pandemics, and this goes towards answering the important question above.

We should remember that the mortality rate was kept under proper control in most European countries during August 2020, when it dropped to a few deaths/week/country. This result was achieved without any vaccination campaign, and the following dramatic growth was due to the virus returning from countries such as the USA, Brazil, India, and Russia (which cannot be considered a European country), which were not capable of controlling the death rate during that same period. China, where the pandemic originated, also apparently flattened its death curve to almost zero without any vaccine. The conclusion is that COVID-19 can also be controlled without vaccines, albeit at extremely high social and economic cost, and this was only not successful because of general health policy incompetence.

Vaccine yes or no

Comparison of the current data regarding countries with and without vaccination campaigns comes out clearly in favour of vaccines because the growth in number of deaths in countries not implementing a vaccination programme is dramatic (see Figure 1 and Figures 6-8). However, in Europe during the summer 2020 the deaths rate was very low and the disease was considered under control without the use of any vaccine.

At the present time, w hile the world death rate (considering all 139 countries) is going down or fluctuating, it is quite definitely growing in the 36 countries without vaccination programmes. However, no correlation between number of deaths and shots of vaccine can currently be found. This may be due to differences between countries since the number of deaths is decreasing in 60% of them, while it is increasing in the remaining 40%. Furthermore,

it may be necessary to get close to herd immunity, as is happening in the UK, the USA and Israel.

Looking at the current data, these three countries have almost flattened their death rate curves. This started between 6 to 8 weeks after their vaccination programmes began, without any further rises. This trend has not been seen in countries such as Brazil, Poland and Italy, where there is an evident increase in the death rate eight weeks after the start of their vaccination programmes (Figures 13-15) .

This may be due to the belief that, once vaccination has started, it is possible to go back to normal life, which is not true at all (see later). Vaccination does not mean the end of the possibility of an outbreak, even though it is understandable that people are frustrated with the nuisance of alternating periods of lockdown.

Even when a country reaches herd immunity, reinfection is still possible due to the nature of this virus, which is most probably already part of our metaorganism. This means that every year will be the same, like for seasonal influenza, and the vaccination programme will continue until true viral disappearance occurs.

This is what we hope will happen if a non-lethal variant becomes prevalent as it did for the Spanish flu [19,20]. Furthermore, more effort should be made to find a treatment for the disease, perhaps with monoclonal antibodies, antiviral drugs, or a simple spray to prevent viral infection [21,22]

The question of adverse reactions to vaccines, such as thromboses and other lethal events, is the subject of many debates and definitely comes down to their risk/benefit ratio, which is generally extremely high with effective vaccines. However, adverse reactions to a drug attract far more attention from the general public, than its efficacy. This debate is becoming a political issue.

Not just vaccines

Besides the deaths, the other dramatic aspect of COVID-19 is the political situation, which can be summarized in a few words: bad information and bad organization.

The information provided has been extremely uncoordinated and the actions taken have been different and somewhat contradictory in every country. This was understandable during the first COVID-19 wave, when the virus was new. However, even after the decrease in death rate in most of Europe during August 2020, the virus was still found and was very aggressive in big countries such as the USA, Brazil, India and Russia.

None of the European governments took this aspect seriously and nothing was done to prevent the possible return of outbreaks. By nature, viruses circulate freely, particularly in these globalized times. This means that:

a) Disinfection should have been implemented meticulously, particularly in places where people often gather.

b) Border controls should have been carried out in the country of origin and country of arrival to isolate positive cases. These controls would not have been highly detrimental to travel.

c) Hygiene should have been promoted through all media channels, considering that the virus does not only reside in saliva but can be found in all secretions.

d) Chronic treatment among the elderly should have been checked by family doctors, and the patients should have been informed that appropriate chronic treatment can ward off death from the virus [23]. Instead, the information that was perceived was that elderly people with chronic diseases were condemned to death [24-26]

e) The experts (e.g. virologists, immunologists and epidemiologists, including those in charge of Scientific Committees) which appeared on TV shows and wrote in the newspapers should have been "peer reviewed" for their specific expertise, as happens for all scientific audiences.

The organization started to show its faults during the vaccine preparation stage. Countries producing vaccines were not allowed to distribute them in the countries of origin since contracts with the big pharmaceutical companies were required as a precondition to obtaining the shots to cover needs. Production levels were lower than agreed and this led to fighting among countries. Some countries produced vaccines but the product was not available until the local regulatory authority approved it. In some cases, some regions of some countries were able to buy and administer vaccines even without local authority approval.

The picture that emerged was a sort of purgatory where everybody was fighting someone else. But the virus did not care about this fighting and carried on undaunted. The second incredibly weak point was the decision over who should administer the vaccine. Leaving aside the fact some vaccines need to be stored at -80 °C, an injection that most people can do by them was allowed to become a bottleneck. There are still arguments over who can administer the vaccine: whether you need a medical doctor, nurse, veterinary surgeon, dentist or pharmacist. Very often a lot of time is lost to comply with bureaucratic requirements.

LEEDELS data

The reason why some countries have not started a vaccination programme is beyond the scope of this research. However, analysis of the LEEDELS data makes it evident that these countries are among the poorest. The obvious consequence is that rich countries will prevail in the competition taking place to obtain vaccines. This means that the virus will be kept viable in poor countries for the next few years.

Analysis of the relationship between the COVID-19 mortality rate and LEEDELS data clearly shows that the disease is more frequent in rich countries, where exchanges due to business and gatherings are the mainframe of society. This is also evident from the positive correlation between urban density and number of deaths.

If the same analysis is carried out in countries where only some vaccination is occurring (without a clear vaccination programme), it is clear that many of them are poor countries, and since "money talks", once the people living there are attacked by the virus, they have difficulty reacting and have to queue up to get vaccines.

The situation in Europe is also pretty much the same: the second wave was much more severe in the poorer countries, mainly located in Eastern Europe [27].

It is not hard to calculate the cost of the vaccination programmes. Considering a price of between 2 and 19 €/shot, the final amount numbers into the billions. Moreover, it is hard to understand why there is such a big difference in the cost of the various vaccines. In any case, it is very big business for the pharmaceutical industry.

CONCLUSION

Vaccination is one of the tools we can use against COVID-19, but it does not currently seem to be sufficient to counteract the mortality rates in many countries on its own. Herd immunity, which it is said is necessary in order to stop deaths due to the virus, is more of a hope than a fact at the moment.

Uncontrolled outbreaks can be seen in many countries and indicate that vaccination has to be accompanied by many other measures, such as disinfection of the places where people gather, hygiene (particularly of the oral cavity), and awareness that the virus is found in all secretions/excretions.

Currently, the evidence that vaccination against COVID-19 can prevent the virus from spreading is more of a hope than a scientific truth. So far only countries close to herd immunity seem to have flattened their death rate curves, while many other countries are still seeing an evident increase, even though their vaccination programmes started over three months ago. The belief that after vaccination everybody will be able to move freely is totally wrong, and proper information should be provided, along with an appropriate health policy.

The problem of health policies has made the limited ability of most governments to tackle the disease very evident. The simplest available tools were forgotten, and-in the end-vaccination became the only reference measure to cover up serious faults. The same inefficiency was seen in the lack of a common strategy for vaccine production, distribution and administration. The world will probably be threatened by this virus every year, and that threat will be particularly severe for the poorest countries until a non-lethal variant becomes predominant.

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AUTHOR CONTRIBUTIONS

UC conceived the trial; GB and UC retrieved all the data; MR carried out the statistical evaluation; UC wrote the text.

CONFLICT OF INTEREST

There are no conflicts of interest.

ETHICAL STATEMENT

This manuscript is original, has not been published before, and is not being considered for publication elsewhere. All the authors mentioned in this manuscript have agreed on its authorship, read and approved it, and given their consent for its submission and subsequent publication.

REFERENCES

1. Worldwide Dashboard. World Health Organization. 2020.
2. Geographical Atlas De Agostini 2020 Deluxe Edition. DeA Planeta Libri. 2020.
3. Central Intelligence Agency. The CIA world factbook 2020-2021. Skyhorse Publishing, New York, USA, 2020.
4. Life expectancy in the World Population. Worlddometer. 2021.
5. Jackson LA, Anderson EJ, Rouphae NG, Roberts PC, Makhene M, Coler RN, et al. An mRNA Vaccine against SARS-CoV-2—Preliminary Report. N Engl J Med. 2020;383(1):1920-1931.
6. Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Development of a remote online collaborative medical school pathology curriculum with clinical correlations. N Engl J Med. 2020;383(1):2603-2615.
7. Voysey M, Clemens SAC, Madhi SA, Weckx LY, Folegatti PM, Aley PK, et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. Lancet. 2021;397(10269):99-111.
8. Logunov DY, Dolzhikova IV, Shcheblyakov DV, Tukhvatulin AI, Zubkova OV, Dzharullaeva AS, et al. Safety and efficacy of an rAd26 and rAd5 vector-based heterologous prime-boost COVID-19 vaccine: an interim analysis of a randomised controlled phase 3 trial in Russia. Lancet. 2021;397(10275):671-681.
9. China Bio-Beijing Company's new coronavirus inactivated vaccine phase III. Sinopharm. 2020.
10. A Second Chinese Coronavirus Vaccine Is Said to Be Effective. The New York Times. 2021.
11. Johnson & Johnson announces single-shot janssen COVID-19 vaccine candidate met primary endpoints in interim analysis of its phase 3 ENSEMBLE trial. Janssen. 2021.
12. CanSinoBIO announces approval for its single-dose COVID-19 vaccine in China. CanSinoBIO. 2021.
13. Bharat Biotech announces phase 3 results of COVAXIN®: India's first covid-19 vaccine demonstrates interim clinical efficacy of 81%. Bharat Biotech. 2021.
14. Da Sois J. Sputnik V, Epivaccorona, Kovivak: What do we know about the three Russian Vaccines?. CNews. 2021.
15. Novavax COVID-19 vaccine demonstrates 89.3% efficacy in UK phase 3 trial. Novavax. 2021.
16. Aguas R, Corder RM, King JG, Gonçalves G, Ferreira MU, Gomes MGM. Herd immunity thresholds for SARS-CoV-2 estimated from unfolding epidemics. BMJ. 2020;27(2):371-418.
17. Global health estimated world health organization. World Health Organization. 2018.
18. Cornelli U, Belcaro G, Cesarone MR, Recchia M, Cotellese R. The COVID-19 history in Italy: Correlations with environmental, demographic variables and chronic diseases therapy. J Med Case Rep. 2020;4(1):1-13.
19. Taubenberger JK, Morens DM. 1918 Influenza: the mother of all pandemics. Emerg Infect Dis. 2006;12(1):15-22.
20. Akin L, Gözel MG. Understanding dynamics of pandemics. Turk J Med Sci. 202;50(SI-1):515-519.
21. Meyers C, Robison R, Milici J, Alam S, Quillen D, Goldenberg D, et al. Lowering the transmission and spread of human coronavirus. J Med Virol. 2021;93(3):1605-1612.
22. Belcaro G, Cornelli U, Cesarone MR, Feragalli B, Bombardelli E, Dugall M, et al. Seven immediate, low-cost management strategies for Covid. Exploiting viral Thermolabity: Possible, immediate solutions. Biomed J Sci & Tech Res. 2020;27(3):20801-20808.
23. Cornelli U, Belcaro G, Cesarone MR, Recchia M, Cotellese R. Covid-19 Aging and Chronic diseases. J Micribiol Infect Dis. 2020;4(6):1-6.
24. Petrilli CM, Jones SA, Yang J, Rajagopalan H, O'Donnell L, Chernyak Y, et al. Factors associated with hospital admission and critical illness among 5279 people with coronavirus disease 2019 in New York City: prospective cohort study. BMJ. 2020;369(1):m1966.

25. Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature. 2020;584(7821):430-436.

26. O'Hearn M, Liu J, Cudhea F, Micha R, Mozaffarian D. Coronavirus disease 2019 hospitalizations attributable to cardiometabolic conditions in the United States: A comparative risk assessment analysis. J Am Heart Assoc. 2021;10(1):e019259.

27. Cornelli U, Belcaro G, Recchia M. The many waves of Covid -19 in Europe. LAP Lambert Academic publishing-Mauritius. 2021.