Cost-Effectiveness Analysis (CEA) of Preventive COVID-19 Vaccines by Quality-Adjusted Life Years (QALYs)

Rabnawaz Khan (khan.rab@fjut.edu.cn)
Fujian University of Technology

Research

Keywords: COVID-19 vaccines, cost-effective analysis (CFA), health, quality-adjusted life years (QALYs)

Posted Date: August 30th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-837252/v1

Abstract

This paper merely presents the dynamic boost of the COVID-19 vaccines. The intensive approach is indicating how the effective COVID-19 vaccine promotes and distributes into various official channels. It enables the exclusive authority to devise a possible way to reduce the economic cost of COVID-19 vaccines and facilitate to a maximum level. The Cost-effectiveness analysis (CEA) method approached with Quality-Adjusted Life Years (QALYs). The key findings are revealing the length of life improves the quality of life of the middle family. The results of QALYs show that Utility Value (UV) by health and the value of statistics in countries in the term of coexistent causation of vaccines. The Pfizer (BNT162b2) and Moderna (mRNA-1273) have instantly created favorable and significant effects probably on many patients, comparatively SARS-CoV-2, AstraZeneca (AZD1222), Russia's Sputnik (AstraZeneca), and Sinopharm Sinovac Biotech. The opportunity cost provides a valuable benefit in the future.

1. Introduction And Overview

Healthcare and its measurement have inevitably to remain an economic activity, invest money, time, and sources for secure human life with various infected and unmeasured diseases. However, the unnecessary consequences of health measures improve human life, and medical institutions exchange the value of life worth with others because of profit, investment, and market penetration medicated product(Pruckner, Schneeweis, Schober, & Zweimüller, 2021). As a global health priority, it's time to conceive about human life and as a nation to identify ways of considering the medicated problems because of the COVID-19 pandemic. And applying for the quality improvement and measurement of human life in various dimensions. Health priorities play a vital role in articulating and effect the health system that is diverting toward Universal Health Care (UHC) (Mensah Abrampah N, 2018; Qian, Chou, & Lai, 2020).

The Food and Drug Administration (FDA) has avoided the Emergency Use Authorization (EUA). In this process, the chloroquine and hydroxychloroquine medication employing for the diagnosing purposes of COVID-19 patients. The FDA recognized these medicines it is not efficient drugs for treatment. In the 550-drug development program (DDP), the FDA has examined 350 trials into an unknown gender. At last, after a long time, SARS-CoV-2 (novel coronavirus) has been introduced, and around 80% of people recover from COVID-19 diseases without specialized medical treatment. According to the World Health Organization (WHO), 1 to 5 patients develop foster illness and have face breathing problems. After the invention of this alternative medicine (SARS-CoV-2), it is thus amenable to the extensive frame of economic analysis is understanding the worth of this medicine and its demand. In the first phase, it's a challenge and risky to lunch in private sectors because of the market penetration with fixation of prices and supplies new and active investor interest.

The Cost-effectiveness analysis (CEA) approach is using to examine as an evaluation tool where the output of the goods (medicines) produced by a project does not count in the monetary term. It shows the interaction of health and pharmaceutical industries, where the benefits are qualitative rather than qualitative. The CEA approach to identify the efficient analysis of SARS-CoV-2 medicine is that of a project or investment (Mihai G. Netea, 2020; New SARS-CoV-2 test is a simple, 2020; Rydyznski Moderbacher et al., 2020). In this acute condition, when all over the world is assuming massive risk because of the COVID-19 pandemic so we should not assess them for their monetary value factor should equally consider the quantitative approach. The cost of the investment divided by the outcome of the selected investment can compute the Cost-Effectiveness Ratio. The economic analysis procedure compares the relative cost of the project and the result of the CEA technique. As nature of evaluation, this technique is a mixed approached of quantitative and qualitative. It is more suitable for the service-related health sector, and this analysis approach does not consider the opportunity costs. Where typical investors' concern about more benefits or business misses.

Figure 1 shows the linear change in total death from January 23 to December 21, 2020. It revealed a modification in the total percentage that 47% reduced by 1% during this period.

The COVID-19 vaccine prevention is perhaps the best hope for the sound world and for ending the pandemic. The U.S Food and Drug Administration (FDA) begin authorizing emergency after that critical situation of deaths. Examine the benefits of COVID-19 vaccines, how they work, side effects, and infection prevention steps. World Health Organization (WHO) has confirmed 444,437 recent cases on December 29, 2020. January 31, 2020: Contemporary evidence showed that people who are affected with the unique coronavirus (2019-nCoV) could turn into infectious before that symptoms were prominent neither the CDC (Centers for Disease Control and Prevention) nor WHO (World Health Organization) have changed their instructions considering the treatment (Dai et al., 2020; Schive, 2020).

On 16-Nov-2020, Johanson & Johnso (J&J) has launched the second phase of the COVID-19 vaccine with the cooperation of the UK National Institute for Health Research (NIHR) and enrolled around 30,000 members in the US, Germany, UK, South Africa, Spain, Philippines, and Colombia. Phase 3 ensemble trial on 1 and 2 dose regimen during September and November and inspected the results of 90,000 participants across the world to avert SARS-CoV-2-mediated COVID-19 (Arthur, 2020).

However, the practical recognition of COVID-19 patients with an occupational attribute for compensation remains an enormous challenge for the unified world. In most countries, the number of related COVID-19 patients identified as positive symptoms, and it much lower than the total estimated burden of COVID-19 patients and their causes.

In this study, SARS-CoV-2 value and health outcomes measures by Quality-Adjusted Life Year (QALY). It estimates the annual numbers of COVID-19 patients, aggregate losses of QALYs, and health measurement costs that could adjust by improving the lifestyle in a secure environment. The QALY remains an attempt to combine two components of health by length and quality of life-i.e. mortality. This technique indicates about extra months or years of the life of reasonable quality when considering treatment for COVID-19 patients. In this study, the health of the COVID-19 patients analyzed by partial healthy, healthy, and perfectly healthy conditions. The utility value of QALYs assigned to treatment based on COVID-19 patients and their anticipated results examined by SARS-CoV-2 (GBS-price IPO), Pfizer (BNT162b2), and mRNA-1273 (Moderna's). When considering the experimental modified these vaccines, and how COVID-19 patient utility value can endure an essential part of the treatment. We analyze and determine a more effective and effective solution to vaccines. This paper comprises a review of scholarly materials on the subject, methodological approaches, findings, and a discussion. We conclude by making recommendations based on our outcomes.

2. Methods And Materials

The study intends to examine the magnitudes and connection of the COVID 19 vaccine and infected confirmed cases of COVID 19. It contains 213 dominant territories from Europe, the USA, Asia, South Africa, and Oceania. The interaction of the COVID 19 vaccine analyzes by cost-effectiveness analysis (CEA) and Quality-Adjusted Life Years (QALYs).

The CEA is a type of evaluation that measures the differences in cost and benefits in minimum intervention with effectiveness measures. The use of the signal logical unit to value health gain. However, measurement units are involved the number of lives saved, the number of out-patient appointments a day in the hospital, or the measurement of drug usage. In this study, we confirm how safe a number can live. The problem is it one dimension, which is only of a diverse inveterate number of patients. The reason is that we don't know about the quality of life of these patients. We need them to live longer and also the number of lives saved, not the quality of lives (Goldman L, 1991). The extensive economic evaluation is limited benefits side to consideration of life expects and age of deaths, the only outcome of treatment. The allocation of outcome health resources is unlikely to reflect the patient's health order needs and quality of live post-treatments. In this study, the CEA is calculating based on the value of statistics (VSL). The value of cost is considering the government donations or contributions. The life in expected years is supposed to calculate on the confirmed number of patients. However, the expected life cost centered on different utility values of life in partial, utility, and other utility. The prescribed vaccines SARS-CoV-2 (GBS-price IPO), Pfizer (BNT162b2), and mRNA-1273 (Moderna's) is practice for the analysis of QALYs.

In this study, QALYs represent the measured value of confirming cases of COVID-19 patients and their benefit of health outcomes with prescribe COVID-19 vaccines. The perspective of health is distinct as a function of the length of life (mortality)

and quality of life (morbidity), but in this case, we estimate only the mortality of life. QALYs carry out an idea about the expected life, how many extra years or months of life a realistic quality of person might gain, the results of different treatment by utility value (F, 2006; Liu, Chen, Cao, & Zhang, 2019). The expected life of patients is computing based on partial healthy (0.25 years), healthy (0.50 years), and perfect healthy (1 year). The calculation of QALYs indicates the quality of life between 1 = perfect healthy and 0 = dead (Pliskin JS). Also, 0.25 QALYs representing a particular patient achieve a partial healthy and fit status only one quarter of a year. The essential function of QALYs indications is to quantify the effectiveness of a modern treatment (SARS-CoV-2, Pfizer, and mRNA-1273) compare to the current treatment for this pandemic situation. It also evaluates the cost-effectiveness of the different vaccines, and this is the cost of prescribing a vaccine to provide a year of the best quality of life available. Also, we ignore the altered life stages and do not consider the specific age of people group. It fact that generally younger have many times more QALYs than older (JA, 2003).

2.1 Cost-effective analysis (CEA) and Quality-Adjusted Life Years (QALYs) techniques

The cost-effective analysis (CEA) technique used on COVID 19 confirmed patients' value of statistics (VSL). The VSL shows three different levels of contribution of money in groups (GP) of countries. Groups are classifying the number of confirmed cases. There are five groups (GP1 to GP5) are analyzed in 213 countries (Table 1). The application of this method is indicating the length of individual patient life. Also, it represents that how QALYs can boost the participation and donation of the government. In this pandemic situation, the opportunity cost of living is more valuable, and it can provide the maximum out to the individual patients and community.

Table 1
Groups distribution

Groups	Cases	Value of statistics life ($) million			Continents					Total Countries
		VSL-1	VSL-2	VSL-3	Europe	America	Asia	South Africa	Oceania	
GP-1	< 10 million	25	50	100	7	5	2	0	0	14
GP-2	less than 10 million	2.5	5	10	23	12	18	5	0	58
GP-3	less than 1 million	0.15	0.25	1.0	14	2	11	23	2	52
GP-4	less than 10000	0.025	0.05	0.1	6	13	4	22	2	47
GP-5	less than 1000	0.0025	0.005	0.01	5	16	7	7	7	42

2.2 Data collection

The paper dataset typically contains from created 1st to 14th December 2020. The number of confirmed cases and death of patients carefully analyzed in five separate continents and groups. There are 213 (55 Europe, 48 USA, 42 Asia, 57 South Africa, and 11 Oceania) countries eagerly examined in GP1 to GP 5. ("European Centre for Disease Prevention and Control," 2020) Understated of the European Centre for Disease Prevention and control measured results show the highest prevention impact of the current vaccine. And the most inflated number of confirmed cases recorded in Europe (Russia, France, UK, Italy, Spain, Germany, and Poland), the USA (America, Brazil, Argentina, Colombia, and Mexico), and two independent countries of Asia (Iran and India).

2.3 Procedures

In the first phase, the continent distributes according to the confirmed number of COVID-19 patients. And the highest number of confirmed cases registered in Russia, the USA, and India. As per QALYs, the expected years of patients are estimated by

0.25 to 1 year. The distribution of the year determined three scenarios. According to the first scenario, imagine a person (confirmed case) is fully healthy but has a risk of unexpected death caused by this infected virus (COVID-19). The newly introduce medicine will execute patients more life. And his life considers as one year (1*100/100 = 1) in excellent health condition. The medicine dose increases a year of life at 100% of the expected quality of life. It would be QALYs of one (Perfect healthy). They expect the live line of the patient based on QALY between 0 and 1(Chen, Xu, & Song, 2020). And the death has indicated with 0 QALY. In the second scenario, the quality of life of an infected person will be only 50% based on the fully healthy person.

The new medicine might give him extra to life but not fully restore him to complete perfect health. The new vaccine will gain (0.5*50/100 = 0.25) life in a healthy situation. Conditionally, the new vaccine doze increases a year of life 50% of the expected quality of life. Therefore, the QALY would be 0.25. In the third scenario, the expected life will increase by partial (0.25 years). The quality of life will be only 25%, and the current vaccine might give him extra life with QALY (0.25*25/100 = 0.0625). As per the expected estimation of QALYs, in the first scenario, the vaccine MD-3 (Mrna1273 Moderna's) is influential on the infected health and provides the maximum probability of his life in perfect health comparatively from the second and third scenario.

Furthermore, it might be possible to calculate the expected life of the confirmed number of patients by (0.25,0.50 and 1) years. And if the expected life will increase in a situation of perfect healthy (10 or more than ten years) condition. So, the QALYs would be at maximum level with 100% experience of the fully healthy situation. And the patient will endure lives (5 to 10) years. Also, with the intervention of (Pfizer BNT162b2) vaccine patient expected 75% healthy. Therefore, the QALY would be 7.5 (10 years*0.75). The partial healthy patient might endure lives (0 to 5) years. Furthermore, with the SARS-CoV-2 vaccine, the QALY would be 1.25 (5 years*0.25).

2.4 Estimation of QALYs by utility values of vaccine

The second phase based on the utility value of life with current vaccines some as following:

2.4.1 SARS-CoV-2 (GBS-price IPO)

Graciously according to GBS Inc, Antibody Biosensor (SARS-CoV-2) manufacture with the coordination of Harvard University in the Department of Wyss Institute. They sufficiently indicate the first modern Biosensor Platform technology with a dedicated nanomaterial coating. Moreover, a saliva-based test for the SARC-CoV-2 begun in New York (NY) in August 2020. Noninvasive SARS-CoV-2 antibody testing castoff estimates the mild symptoms and apparent prevalence of the rare SARS-CoV-2 infection (Randad et al., 2020). They unanimously declared that more than 23 million COVI-19 patients had registered, and only 50 to 80% of COVID-19 cases didn't diagnose because of lack of vaccination in August 2020.

In November 2020, there were 212 COVID-19 vaccines introduced in clinical (48 vaccines) and principle (164 vaccines) evaluation by World Health Organization (WHO). Of these, only 11 vaccines can have reached Phase III trials, and six vaccines early tested in Russia and China have not completed the third trial (Chakraborty, Mallajosyula, Tato, Tan, & Wang, 2021; "DRAFT Landscape of COVID-19 Candidate Vaccines ", 2020; "New York Times.," 2020). Saliva-based glucose introduces and fixed the GBS price at $17 (23 December 2020). It is evolving saliva-based (sb) test for SARS-CoV-2 with diabetes management in China. It raised $22 million (m) by proposing 1.3 (m) units within the range of $16 to $18. As for managing the unexpected situation of COVID-19, the company offered 0.2 (m) more units than predicted.

2.4.2 Pfizer (BNT162b2)

After the 2nd and 3rd clinical trial Pfizer-BioNTech, the vaccine has introduced. And two shots (21 days apart) to preventing laboratory-confirmed and manage COVID-19 illness in people without any other indication of infection. The 95% effective patients result of the Pfizer vaccine have increased. Therefore, in the international market, the vaccine demand raised because it works in average conditions and provided maximum results (Lin & Wang, 2021). On 11 December 2020, the Emergency Use Authorization (EUA) permitted to announced the Pfizer-BioNTech vaccine at $19.50 per dose in the USA and other countries (Latkin, Dayton, Yi, Konstantopoulos, & Boodram, 2021; Terry, 2021).

2.4.3 mRNA-1273 (Moderna's)

On 16th November 2020, Moderna has reported 94.5% effectiveness trial results from 30,000 participants in the 3rd phase. According to FDA, the initial price of the vaccine introduced between $25 to $37. And, there are 2 (shots 28 days apart) needed for each infected patient. On 23rd November 2020, according to Moderna, the vaccine price adjusted between $32 to $37 per dose. The European Union was reportedly conferring an agreement to keep the per-dose price under $25 (Cao, 2020). The Pfizer and BioNTech vaccine BNT162b2 more than 90 effectually, and no federal funding considering for manufacturing. It needs to be diluted by the pharmacist. Initially, 50 million doses suggest being manufacture by the end of 2020 and another 1.3 billion next year. Also, comparatively the Moderna vaccine mRNA-1273 was 94.5% effective in preliminary trials and developed in collaboration with the U.S. government. And it does not require dilution. Total 20 million doses suggest being available by the end of 2020 and up to 1 billion more next year (Weintraub, 2020).

2.5 Validation incidences of work related by estimating the QALYs

QALYs estimation is typically based confirmed number of likely patients, model years, and the utility value. In this study, the QALYs are computing for each content, where the number of patients individually multiple with years and then utility value. The expected QALYs value (QA-1, QA-2, and QA-3) value is sufficiently indicating the individual country and their confirmed patients. The moral value of QALYs distributed on the economic basis of utility value, where the three-different vaccination (MD-1, MD-2, and MD-3) shows the intervention of effective vaccine and their profound effects on particular patients. The MD-3 value is more effective comparatively MD-2 and MD-1. In the rare case of different prices of vaccines shows the organizational QALYs effectiveness. It indicated the divine intervention of vaccines on variant patients. Additionally, where the quality of life ignores because the indifferent contents different number of likely patients have carefully scrutinized.

2.6 Difference of QALYs

Potential QALYs difference confirms the operational effectiveness of different vaccines. The estimated results of QA-3 and QA-1 indicate the difference of vaccine effects based on diverse contents. Plus, the anticipated results are representing the quality of the vaccine. Besides, an effective vaccine gives more life to the infected patients under ordinary circumstances. Figure 2 shows the diverse contents QALYs with a liner line of leading QA-3 cause of highly effective results differentiate the excellent quality of life is computing in the rare case of the mRNA-1273. The maximum number of likely patients might naturally increase QALYs in perfect health condition.

MD-3 vaccine (mRNA-1273-Moderna's) is highly effective. The efficiency rate of this vaccine is 94.5% as competitively Pfizer-BioNTech, Adenovirus-AstraZeneca (AZD1222), ENSEMBLE 2 (Johnson & Johnson), Russia's Sputnik V Vaccine (AstraZeneca), and Sinovac Biotech. (Table 2)

Table 2
Description of Vaccines

Vaccines	Date	Type	Developer	Countries	Efficiency rate (about)	Doses	Price per/dose
Pfizer-BioNTech	December 11, 2020	mRNA	BioNTech	Germany	95%	2	$19.50
Moderna's mRNA-1273	December 18, 2020		NIAID	USA	95%		$25-$37
AstraZeneca (AZD1222)	January 12, 2021	Adenovirus-based	University of Oxford	Europe and USA	70%		$25-$37
ENSEMBLE 2 (Johnson & Johnson)	April, 2021		USA	USA	72% (USA) 66%(Overall) and 85% (severe disease)	1	$10
Russia's Sputnik V Vaccine (AstraZeneca)	March or April, 2021		GRIEM	Russia	91.4%	2	$10
Sinopharm Sinovac Biotech	January 13, 2021	SARS-CoV-2	Biopharmaceutical	China	50.38%	2	$50.38 to $91.25
Note: United State National Institute of Allergy and Infectious Diseases (NIAID), and Gamaleya Research Institute of Epidemiology and Microbiology (GRIEM)							

2.7 Value of statistics

According to Table 1 value of statistics is computed scientifically based on VSL donations or outstanding contributions. The contribution value of VSL base on the considerable number of confirmed patient's cases in the groups (GP-1 to GP-2) between 25 to 100 million (USD). And the individual government participation is efficiently computed by the confirmed number of patients in different contents.

3. Results And Discussion

For the QALYs model, the confirmed number of cases differentiate into five groups. Including the different contents. And in the GP-1, there is a total of 17 (7 Europe, 5 America, and 2 Asia) countries carefully examined individually based on their contents. The highest death ratio is recorded in Italy (0.034), Colombia (0.027), and Iran (0.047) based on the population in the contents of Europe, America, and Asia.

As per accurate QALYs estimation, the value of statistics indicated that each patient reimburses cash 13.55 (VSL-1), 27.11(VSL-2), and 54.23(VSL-3) under the utility value of MD1 to MD-3. We efficiently computed the average values VSL-1(14.596), VSL-2(29.192), and VSL-3(58.384) of 7 Europe; VSL-1(11.876), VSL-2(23.752), and VSL-3(47.504) of 5 America; VSL-1(12.543), VSL-2(25.087), and VSL-3(50.174) of 2 Asian countries in the GP-1 for estimation of vaccines donation.

Figure 3 shows that all three above vaccines effectiveness after two doses, the reimbursement of vaccination cost will be 39% (34/VSL-1),69.5%(39/VSL-2), and 78.60%(69/VSL-3), and the remaining amount the patient will recover by self. Likewise, this confirmed number of patient claims at 0.51%, 0.89% (in the case of MD-1 and MD-2) in Colombia. And 0.663% (in the case of MD-1) in Iran from the government or donations agencies. Figure 4 shows the outstanding contribution of a charitable donation in the value of statistics (VSL), as for two effective doses. There are 213 independent countries individually representing their donation in a considerable percentage the Germany, Poland, Colombia, Mexico, and Iran in the GP-1. Second, Slovakia, Moldova, Greece, Denmark, Bosnia, Egypt, Ethiopia, Tunisia, Guatemala, Honduras, Venezuela, Puerto_Rico, Qatar, Oman, Palestine, and Myanmar in the GP-2. Third, Malta, Guinea, Botswana, Cape_Verde, Zimbabwe, Mauritania,

Jamaica, Maldives, and Tajikistan in the GP-3; Gibraltar, Sao_Tome, Sint_Maarten, and Vietnam in the GP-4. Fourth, Holy_See, Saint_Vincent, Dominica, British_Virgin_Island, Grenada, Saint_Kitts, Falkland Islands, Greenland, Montserrat, Anguilla, Northern_Mariana_Island, Fiji, New_Caledonia, Solomon_Islands, Wallis_and Futuna, Vanuatu, Laos, and Timor_Leste in GP-5. Many patients unincluded in the donation list because of the least number of confirmed patients registered in the different hospitals. In this case, each country's government individually patriciate without any extra funding for each patient. The x-axis indicates the number of countries and the Y-axis on % of donations of each country patient.

(Sekar, January 11, 2021) January, 11 (2021) U.S. Food and Drug Administration (FDA) has sanctioned to use COVID-19 vaccine funded by Pfizer and Moderna. The Operation Warp Speed (OWS) have purchased millions of vaccine doses from supplier, and it controlled by Health and Human Services (HHS) and the Department of Defense (DOD). Also, OWS instigating a national vaccine program (NVP) by coronavirus supplemental appropriation acts (FY2020, FY2021). In particular, $30 billion (FY2020) and $22.945 billion (FY2021) are reserved for the Public Health and Services Emergency Fund (PHSSEF) for development, manufacturing, and purchase from the supplier until September. 30, 2024.

("ADB Announces $9 Billion COVID-19 Vaccine Initiative for Developing Asia," 2020) Asian development bank (ADB) has launched $9 billion for the Asia Vaccine Access Facility (APVAX. Additionally, sustenance investment activities to build vaccine. (Sajid) One of the leading companies (ANKARA) has secured about $500 million in funds for the development, manufacturing, and distribution by Sino Biopharmaceutical. Initially, the company has manufactured 300 million doses of Sinovac. Besides, China has donated a vaccine to Pakistan on February 1st, 2021, to prevent seriously confirmed COVID-19 cases. Hence, Pakistan has already lost more than 11 thousand live cause of this outbreak (Huaxia, 2021a).

Figure 5 shows the confirmed number of COVID-19 patients (less than 10 million) in 58 (23 Europe, 5 South Africa, 12 America, and 18 Asia) countries based on their contents. The highest death ratio recorded in Bosnia (Europe), Tunisia (South Africa), Ecuador (America), and Myanmar (Asia) with 0.032%, 0.034%, 0.068%, and 0.020% based on the confirmed number of COVID-19 patients. QALYs estimation indicated the value of years (partial health, healthy, and perfectly healthy) and the utility value used in all the groups. The value of statistics representing that each patient will be reimbursed donations from the funding agencies for vaccines. We computed the average values of one dose VSL-1(11.476), VSL-2(22.953), and VSL-3(45.906) of 23 Europe; VSL-1(14.716), VSL-2(29.433), and VSL-3(58.866) of 5 south Africa; VSL-1(14.602), VSL-2(29.204), and VSL-3(58.408) of 12 America; VSL-1(11.891), VSL-2(23.781), and VSL-3(47.563) of 18 Asian countries in the GP-2 as for estimation of vaccine donation (Table 3). Same as above, vaccination cost computed (Two dose price/VSL) estimation of the reimbursement Fig. 3.

Table 3
Average value of statistics (two dose)

Groups	Continents (No of Countries)	Average % (value of statistics of two doses)		
		VSL-1	**VSL-2**	**VSL-3**
GP-1	**Europe (7)**	0.429	0.749	0.846
	USA (5)	0.349	0.609	0.688
	Asia (2)	0.369	0.643	0.727
GP-2	**Europe (23)**	0.338	0.589	0.665
	South Africa (5)	0.433	0.755	0.853
	USA (12)	0.429	0.749	0.846
	Asia (18)	0.350	0.610	0.689
GP-3	**Europe (14)**	0.141	0.204	0.462
	South Africa (23)	0.215	0.312	0.705
	USA (2)	0.212	0.308	0.696
	Oceania (2)	0.220	0.320	0.722
	Asia (11)	0.122	0.178	0.401
GP-4	**Europe (6)**	0.366	0.637	0.720
	South Africa (22)	0.243	0.424	0.480
	USA (13)	0.174	0.304	0.344
	Oceania (2)	0.263	0.459	0.518
	Asia (4)	0.283	0.494	0.558
GP-5	**Europe (5)**	0.706	-	-
	South Africa (7)	0.157	0.273	0.309
	USA (16)	-	-	-
	Oceania (7)	-	-	-
	Asia (7)	0.743	-	-

Figure 6 shows the confirmed number of COVID-19 patients (less than one hundred thousand) in 52 (14 Europe, 23 South Africa, 2 America, 2 Oceania, and 11 Asia) countries based on their contents. The highest death ratio recorded in Ireland (Europe), El_Salvadao (South Africa), Jamaica (America), Australia (Oceania), and Kyrgyzstan (Asia) with 0.027%, 0.028%, 0.023%, 0.032%, and 0.016% based on confirm number of COVID-19 patients. We computed the average values of one dose VSL-1(4.780), VSL-2(7.966), and VSL-3(31.866) of 14 Europe; VSL-1(7.299), VSL-2(12.165), and VSL-3(48.662) of 23 south Africa; VSL-1(7.206), VSL-2(12.014), and VSL-3(48.041) of 2 America; VSL-1(7.477), VSL-2(12.462), and VSL-3(49.851) of 2 Oceania; VSL-1(4.155), VSL-2(6.925), and VSL-3(27.701) of 11 Asian countries in the GP-3 as for estimation of vaccine donation. Same as above cost of the vaccine was computed (Two dose price/VSL) for calculating the reimbursement.

Figure 7 shows the confirmed number of likely COVID-19 patients (less than ten thousand) in 47 (Six Europe, 22 South Africa, 13 America, two Oceania, and four Asia) countries based on their contents. The highest death ratio recorded in San Marino (Europe), Somalia (South Africa), the Bahamas (America), Guam (Oceania), and Yemen (Asia) with 0.026%, 1%, 0.021%, 0.016%, and 0.290% based on confirming the number of COVID-19 patients. We efficiently computed the average values of

one effective dose VSL-1(12.427), VSL-2(24.855), and VSL-3(49.711) of six Europe: VSL-1(8.274), VSL-2(16.548), and VSL-3(33.097) of 22 South Africa; VSL-1(5.926), VSL-2(11.852), and VSL-3(23.705) of two America; VSL-1(8.943), VSL-2(17.886), and VSL-3(35.771) of two Oceania; VSL-1(9.631), VSL-2(19.262), and VSL-3(38.525) of four Asian countries in the GP-4 as for accurate estimation of vaccine donation.

Figure 8 shows the confirmed number of COVID-19 patients (less than one thousand) in 42 (5 Europe, 7 South Africa, 16 America, 7 Oceania, and 7 Asia) countries based on their contents. The highest death ratio recorded in Isle_of_Man (Europe), United_Republic_of_Tanzan (South Africa), Antigua_and_Barbuda (America), Fiji (Oceania), and Taiwan (Asia) with 0.067%,0.041%, 0.027%,0.043%, and 0.009% based on confirming several COVID-19 patients. We computed the average values of one dose VSL-1(24.007), VSL-2(48.015), and VSL-3(96.030) of 5 Europe; VSL-1(5.332), VSL-2(10.664), and VSL-3(21.328) of 7 south Africa; VSL-1(61.741) of 16 America; VSL-1(25.265), and VSL-2(50.532) of 7 Asian countries in the GP-5 as for estimation of vaccine donation.

4. Discussion

The estimated results of cost-effectiveness analysis (CEA) and Quality-Adjusted Life Years (QALYs) show the confirmed number of COVID-19 patients in five continents (213 countries) from the period of 31st December 2019 to 14th December 2020. The indicated technique of this study represents mRNA-1273 (Moderna) effective vaccine is more effective and efficient. SARS-CoV-2 (GBS-price IPO) and Pfizer (BNT162b2) are weak, therefore not strongly affected on different COVID-19 patients. Based on expected (0.25,0.5 and 1) year and utility value (17,19.5 and 34.5) dollars QALYs and CEA estimated. Considering the above analysis, we make the following discussion

The COVID-19 pandemic is an economic revolution in the modern history of medical science. We accurately detect this pandemic first in Wuhan, China. Because of the imprecise or economic uncertainty instantly surrounding its spread, the SARS-CoV-2 virus rapidly spread to other parts of the world. It promptly declared that the possible outbreak a pandemic from the World Health Organization (WHO) in March 2020. Over 375 Chinese cities reported COVID-19 confirmed cases, but about 79% of infection cases across that period didn't heighten (Haridy, March 16, 2020; Olubiyi, Olagunju, Keutmann, Loschwitz, & Strodel, 2020). The possible spread of the infectious virus in China was intense because of its untimely detection (WorldOmeter, July 18, 2020). This silent transmission blew out instantly and typically spread within the independent country 32–34] China implemented strict measures to control the COVID-19 in February 2020.

After 16th November 2020, Moderna effectively reported a 94.5% effective rate shows the high effectual demand in the international market for all funding agencies and potential donors. Therefore, the COVID-19 vaccine program could face similar challenges to those faced by prior vaccines. USA, Turkey, Slovenia, Andorra, and Monaco show the highest number of confirmed patients. Their accurate QALYs estimation represents 43.58% (QA-1/QA-2) and 28.26% (QA-2/QA-3) in the group (GP-1 to GP-5). Therefore, the above estimation properly representing that mRNA-1273 is 56.41% and 71.73% effective from GBS-price IPO and BNT162b2.

As per daily news SABAH ("Turkey exceeds 2 million COVID-19 vaccination ", 2021) Dec 30, 2020, Turkey approved Sinovac (developed by China) vaccine under the consideration of Health Ministry Laboratories (HML) and received emergency approval. Jan 14, 2021, Turkey unanimously approved Sinovac and paving the way for the rollout of Turkey's vaccination (Ankara's) program with coordination of health care (Fraser, 2021). After the first shots (Sinovac) to the health minister (Fahrettin Koca), the Turkey medicine and medical agency approved and announced to deliver the concerned department. Also, three million (Sinovac) doses are already received. Turkey scheduled to collect a total of 50 million doses (Sevinclidir, 2021). Brazil, Turkey, and Indonesia have examined an effective Sinovac vaccine that is 65–91% effective at protection against COVID-19. Global health has already declared that if the vaccine is at least 50% would use in an emergency. Before 4.5 (million) doses were announced to procure by Pfizer (BioNTech) initially and then 30 million more but although it was ongoing. On Feb 8, 2021, Peru received the first consignment of Sinovac Biotech. The next consignment tentatively scheduled arrives on Feb 13, (Dogan, 2021). Furthermore, Indonesia has also received 3 million doses of effective Sinovac Biotech

vaccine. We accurately estimated that the Sinovac Biotech vaccine was rarely effective from Pfizer and mRNA-1273. Therefore, the QALYs estimation results show indecisive results. The mRNA-1273, GBS-price IPO and BNT162b2 are more effective than Sinovac. So, the QALYs (Years) is sufficiently indicated that COVD-19 patients included in partial health condition and their live estimation around or less than 0.25 years without the standard of quality of life.

(Ralev, 2021) shows that Slovenia approved mRNA-1273 and typically receive a total of 2 million doses at the end of 2021, which is enough for 1.1 million confirmed patients. Besides, 1.4 million doses of the effective AstraZeneca vaccine have been registered and approved by Medicines Agency. And on Feb 1, 2021, they received 9200 and 245000 doses in the first quarter. The European Commission produces actions and accelerates vaccination campaigns, intending to vaccinate 70% of the adult population to prevent this pandemic (Overview of the implementation of COVID-19 vaccination strategies and vaccine deplopment plans in the EU/EEA, 2021). After Jan 28, 2021, at least 22 countries accurately reported and sustenance administrating policies to manage the COVID-19 pandemic from Moderna. Jan 30, 2021, Algeria start the COVID-19 vaccination program with coordination of Russian shot (Sputnik-V). The first batch of 0.5 million had promptly ordered for prevention ("Algeria starts COVID-19 vaccination drive with Russian shots," 2021). In Australia, the Pfizer/BioNTech has been registered and approved by Therapeutic Good Administration (TGA) and invested $363 million to support R&D and provide an effective vaccine for the spread of COVID-19 ("About COVID-19 vaccines," 2021). A Chinese company (Sinopharm) has similarly developed Sinovac work as Pfizer and Moderna. Dec 30, 2020, trials of the effective vaccine showed that it correctly was 79% effective-lower than Pfizer and Moderna. January 2021, several Asian (Singapore, Malaysia, Philippines, Pakistan, Indonesia, Turkey, Brazil, Chile, UAE, and Bahrain) have approved Sinovac and gradual rollout with different vaccination programs ("China approves Sinovac Biotech COVID-19 vaccine for general public use ", 2021). In the diplomacy race of vaccine China dearly wins and pledge to set aside $2bn for African continents. While the offer to the Caribbean and Latin American a $1bn loan to buy vaccines ("Covid:What do we know about China's coronavirus vaccines," 2021; Motta, 2021). In this economic situation, the accurate estimation of QALYs has indicted that partial healthy condition of likely patients without the moral standard of quality of modern life but at least reduce the death rate. However, the excellent health condition of potential COVID-19 patients with the first year after two effective doses of the mRNA-1273.

(Andorra COVID-19, 2021) The EU has approved only Pfizer and Moderna vaccines for preventing this outbreak so far, Andorra implementing the Pfizer vaccine and employing it for the vaccination campaign. Alyssa McMurtry was representing that Spain will deliver 30,000 doses of the Pfizer vaccine. Also, France has agreed to supply Moderna and AstraZeneca to Andorra for prevention and control of this epidemic situation (McMurtry, 2021). Spain will receive 4.5 million doses end of this march. And t's enough for 2.3 million people. With the coordination of the Council of Europe Development Bank (CEB), Andorra purchases COVID-19 vaccines. In Sep 2020, CEB approved public financing facility (PFF) of €12 million to Andorra. It aimed to prevent and fight against COVID-19. In Jan 2021, Andorra announced a loan utilized for the COVID-19 vaccination program ("Funding vaccinations. Fighting the virus ", 2021). The African Centers for Disease Control and Prevention (CDC) commended the financial gap with African-Import Bank (AIB) in retrieving the COVID-19 vaccine in South Africa. Africa Medical Supplies Platform (AMSP) will play a significant role and secure 270 million COVID-19 doses (Pfizer) with African Vaccine Acquisition Task Team (AVATT) (Huaxia, 2021c). In Oceania countries, Guam administered 12,637 vaccine doses. And 1,760 people have been fully vaccinated (Pfizer) with the department of public health and social services (Staff, 2021). Also, China delivered 150,000 COVID-19 doses to Syria. As for the fight against the COVID-19 pandemic with the coordination of the health ministry. ("China to send 150,000 doses of COVID-19 Vaccine to Syria," 2021) The finding of this study clearly shown that QALYs (Years) in a healthy condition with 0.5 years after two doses of Pfizer. The CEB funding would be adjusted and used for the impost of VSL-2 and VSL-3 for the preclusion of the COVID-19 pandemic.

(Errami, 2021) Monaco vaccination center approved Pfizer under the governing bodies and declared vaccination process extend to the entire population with opposed groups. (Chereau, 2021) The first COVID-19 vaccine took place on Dec 31, 2020. According to Dr. Katherine O'Brien (WHO-director of immunization), AstraZeneca is the effective vaccine on the South African variant. And 90% of new COVID-19 cases vaccinate by one million doses of AstraZeneca (Oxford). (huaxia, 2021b) China has decided to provide vaccines to Papua New Guinea (PNG) and strains to overcome the pandemic situation. (Australia, 2021) The Australian governing bodies also have committed to giving $500 million to PNG to support health security and recovery of

the economy for this pandemic. (Unurzul.M, 2021) Mongolia human drug council approved Pfizer, AstraZeneca, and Moderna vaccines. They also declared that to provide COVID-19 vaccine every entire population with coordination of World Health Organization (WHO). The finding of this study clearly shown that QALYs (Years) in a healthy and excellent healthy condition with 0.5 to 1 years. And dynamic strategic policies, donations of different governments, and donor agencies extent to the VLS of human life.

It can provide excellent health perceptive to infected patients. As the mRNA-1273 vaccine flattered the frontrunners of the COVID-19 pandemic, challenges on the formulation of this vaccine and immovability became graciously ostensible for the unified world in highly affected areas of all continents (Crommelin, Anchordoquy, Volkin, Jiskoot, & Mastrobattista, 2020). It has been accepted from the WHO for the emergency use listing and accordingly fulfills WHO's criteria for Strategic Advisor Group of Experts (SAGE) consideration (Sevinclidir, 2021). Therefore, the QALYs estimation shows a more effective technique by expected year, and quality of life will be ignoring. According to Jackson et al., Moderna is a precise important vaccine, delivered the likely essential of T-cell immunity to vaccination against COVID-19 and produce cytokines (T-Cell Responses), state that anti-COVID vaccine (Oronsky, Gruber, Reiners, & Reid, 2021).

5. Conclusion And Recommendations

This study investigates cost-effective analysis (CEA) of effective COVID-19 vaccine quality-adjusted life years (QALYs) in five continents (213 countries). To examined SARS-CoV-2 (GBS-price IPO), Pfizer (BNT162b2), and Moderna (mRNA-1273) vaccine effects in separate continents typically based on the confirmed number of patients. We gainfully employ modern QALYs techniques. Because three COVID-19 vaccine prices Value of Statistics (VLS) computed individually, this paper uses level data of the European Centre for Disease Prevention and Control, discovered continents, countries, confirmed cases, and deaths cases. Employing the CEA technique, we also analyzed the vaccine's operational effectiveness for the continents, price of the vaccine, and availability by different health ministries and funding agencies.

The consistent results of QALYs show that Utility Value (UV) by partial healthy (0.25), healthy (0.5), and perfect healthy (1) based on years in 213 countries (Five continents). Additionally, the value of statistics (VLS) in countries in coexistent causation of vaccines. This finding shows that Pfizer (BNT162b2) and Moderna (mRNA-1273) have caused beneficial and significant effects probably on many likely patients, comparatively SARS-CoV-2 (GBS-price IPO), AstraZeneca (AZD1222), Russia's Sputnik (AstraZeneca), and Sinopharm Sinovac Biotech. The EU, American, South Africa, Oceania, and Asia have heartily approved Pfizer and Moderna vaccines for preventing this outbreak so far, most countries also implementing the AstraZeneca (AZD1222), ENSEMBLE 2, Russia's Sputnik (AstraZeneca), and Sinopharm Sinovac Biotech vaccine and employing it as for the vaccination campaign. The accurate QALYs estimation typically shows the UV and expected life of likely COVID-19 patients. Plus, we presented CEA analysis by the value of statistics (VLS) based on donation, and prices of vaccines reduce the flow of this possible outbreak in continents. The direct result from QALYs amply provides empirical evidence that the potential COVID-19 patient's social life is more valuable equaled to the price of the COVID-19 vaccine. The excellent quality of life precious is between 1 and 0, so each country should invariably respond to properly implement effective strategies for maximum protection against COVID-19 with the most magnificent possibility. To be specific, Pfizer and Moderna obtain a 95% effective rate, while other vaccines (AstraZeneca, ENSEMBLE 2, AstraZeneca, and Sinovac) typically have 50.38–70% significant results against COVID-19. This finding voluntarily contributes to the unique (Effective COVID-19 vaccine) results of the QALYs from the previous results.We base it on the technical commission immunization system of each continent. The COVID-19 vaccine could confront similar challenges to those faced by prior vaccination programs.

WHO program to lower the stress of COVID-19, it necessary to consider individual states. The MOH programs subsidize to reduce this pandemic with vaccines and adhere to the regulatory requirements under health projects. In this respect, the European and American should analyze and monitor other countries' pandemic situations and check the sources of vaccine to make sure their efforts are productive in a healthy sense. WHO Strategic Advisory Group of Experts (SAGE), European Centre for Disease Prevention and Control (ECDC), U.S. Department of Health & Human Services (HHS), African Centers for Disease Control and Prevention (CDC), and China National Biotec Group (CNBG) are the primary market driver for COVID-19 production

and distribution with coordination of funding bodies. Each continent should implement and develop supplemental policies or vaccinated programs to improve and expand the COVID-19 vaccine to comply with the increasing demand for a healthy and secure life. Additionally, the WHO policies and tactical strategies can develop a more dynamic structure for vaccination. Provisional/federal governments, regional health organizations, funding, donor agencies, and local communities to foster practical strategies for reducing and preventing this COVID-19 outbreak.

6. Declarations

Funding: Fujian university of technology

Conflicts of interest/Competing interests: Not applicable

Availability of data and material: Dataset is already attached in Supplementary Material portion

Code availability: Excel or EViews 10

Authors' contributions: Not applicable

Ethics approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee.

Consent to participate: Not applicable

Consent for publication: Not applicable

7. References

1. About COVID-19 vaccines. (2021). Retrieved from http://www.health.gov.au/initiatives-and-programs/covid-19-vaccines/about-covid-19-vaccine#learn-about-covid19-vaccine-
2. ADB Announces $9 Billion COVID-19 Vaccine Initiative for Developing Asia. (2020). Retrieved from https://www.adb.org/news/videos/adb-announces-9-billion-covid-19-vaccine-initiative-developing-asia
3. Algeria starts COVID-19 vaccination drive with Russian shots. (2021, January 30,2021). Retrieved from http://apnews.com/article/africa-health-algiers-coronavirus-pandemic-algeria-821c1ec10a1fe4371fd56fdaf42498bc
4. *Andorra COVID-19*. (2021). Retrieved from Andorra http://www.govern.ad/covid19_newsletter/en/
5. Arthur, R. (2020, 16-November). J&J launched Phase 3 trial for 2-dose COVID-19 vaccine. Retrieved from https://www.biopharma-reporter.com/Article/2020/11/16/J-J-launches-Phase-3-trial-for-2-dose-COVID-19-vaccine
6. Australia, G. (2021). Australia providing $144 million to help Papua New Guinea procure and deliver safe and effective COVID-19 vaccine Retrieved from http://reliefweb.int/report/papua-new-guinea/australia-providing-144-million-help-papua-new-guinea-procure-and-deliver
7. Cao, S. (2020). COVID-19 Vaccine Price Revealed From Pfizer, Moderna, and AstraZeneca. Retrieved from http://observer.com/2020/11/covid19-vaccine-price-pfizer-moderna-astrazeneca-oxford/
8. Chakraborty, S., Mallajosyula, V., Tato, C. M., Tan, G. S., & Wang, T. T. (2021). SARS-CoV-2 vaccines in advanced clinical trials: Where do we stand? *Advanced Drug Delivery Reviews*. doi:https://doi.org/10.1016/j.addr.2021.01.014
9. Chen, J., Xu, C., & Song, M. (2020). Determinants for decoupling ecnomics growth from carbon dioxide emissions in China *Regional Environmental Change, 20*(11).
10. Chereau, A. (2021, 20 January). Results:there weeks after the start of vaccination in Monaco, where are we? *Monaco Tribune*. Retrieved from http://www.monaco-tribune.com/2021/01/bilan-trois-semaines-apres-le-debut-de-la-vaccination-a-monaco-ou-en-est-on/

11. China approves Sinovac Biotech COVID-19 vaccine for general public use (2021). Retrieved from http://www.channelnewsasia.com/news/asia/china-covid-19-vaccine-sinovac-biotech-general-public-use-14126284
12. China to send 150,000 doses of COVID-19 Vaccine to Syria. (2021). Retrieved from http://news.cgtn.com/news/2021-02-05/China-to-send-150,000-doses-of-COVID-19-vaccine-to-Syria-XDr8Y39GCY/index.html
13. Covid:What do we know about China's coronavirus vaccines. (2021, 14 January). Retrieved from http://www.bbc.com/news/world-asia-china-55212787
14. Crommelin, D. J. A., Anchordoquy, T. J., Volkin, D. B., Jiskoot, W., & Mastrobattista, E. (2020). Addressing the Cold Reality of mRNA Vaccine Stability. *Journal of Pharmaceutical Sciences*. doi:https://doi.org/10.1016/j.xphs.2020.12.006
15. Dai, L., Zheng, T., Xu, K., Han, Y., Xu, L., Huang, E., . . . Gao, G. F. (2020). A Universal Design of Betacoronavirus Vaccines against COVID-19, MERS, and SARS. *Cell, 182*(3), 722-733.e711. doi:10.1016/j.cell.2020.06.035
16. Dogan, S. (2021). Peru receive first batch of Chinese COVID-19 vaccine. Retrieved from http://www.aa.comtr/en/americas/peru-receives-first-batch-of-chinese-covid-19-vaccine/2137079
17. DRAFT Landscape of COVID-19 Candidate Vaccines (2020). Retrieved from https://scholar.google.com/scholar_lookup?title=DRAFT%20Landscape%20of%20COVID-19%20Candidate%20Vaccines&publication_year=2020&author=W.H.%20Organization
18. Errami, N. (2021, January 13). Monaco:vaccination centre, appoitnment, where and how to get vaccinated? *Monaco Tribune*. Retrieved from http://www.monaco-tribune.com/2021/01/monaco-centres-de-vaccinations-prise-de-rendez-vous-ou-et-comment-se-faire-vacciner/
19. European Centre for Disease Prevention and Control. (2020). *An agency of the European Union* Retrieved from https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide
20. F, S. (2006). Calculating QALYs, comparing QALY and DALY calculations. . *Health Policy Plan, 21*(5), 402-408. doi:10.1093/heapol/czl018
21. Fraser, S. (2021). Turkey approves China-based Sinovac vaccine's emergency use. Retrieved from https://apnews.com/article/turkey-china-coronavirus-pandemic-coronavirus-vaccine-ac68dcf62293e0cc70942a1c218681a8
22. Funding vaccinations. Fighting the virus (2021). Retrieved from http://coebank.org/en/news-and-publications/projects-focus/funding-vaccinations-fighting-virus/
23. Goldman L, W. M., Goldman PA, Williams LW. . (1991). Cost-effectiveness of HMG-CoA reductase inhibition for primary and secondary prevention of coronary heart disease. . *JAMA, 265*(9), 1145-1151.
24. Haridy, R. (March 16, 2020). Study finds COVID-19 spread in China fueled by "stealth transmission". Retrieved from https://newatlas.com/health-wellbeing/study-covid-19-spread-china-mild-undocumented-cases-stealth-transmission/
25. Huaxia. (2021a). China-donated COVID-19 vaccines arrive in Pakistan. Retrieved from http://www.xinhuanet.com/english/2021-02/01/c_139712915.htm
26. huaxia. (2021b). China to assist Papua New Guinea with vaccine:FM. *Xinhua Net* Retrieved from http://www.xinhuanet.com/english/2021-02/05/c_139723973.html
27. Huaxia. (2021c). Roundup:Africa CDC commends African Export-Import Bank for financing COVID-19 vaccine. *Xinhuanet* Retrieved from www.xinhuanet.com/english/2021-01/20/c_139684657.html
28. JA, P. L. a. S. (2003). Problems and solutions in calculating quality-adjusted life years (QALYs). *HEalth Qual Life Outcomes, 1*(80).
29. Latkin, C. A., Dayton, L., Yi, G., Konstantopoulos, A., & Boodram, B. (2021). Trust in a COVID-19 vaccine in the U.S.: A social-ecological perspective. *Social Science & Medicine, 270*, 113684. doi:https://doi.org/10.1016/j.socscimed.2021.113684
30. Lin, B., & Wang, M. (2021). The role of socio-economic factors in China's CO2 emissions from production activities. *Sustainable Production and Consumption, 27*, 217-227. doi:https://doi.org/10.1016/j.spc.2020.10.029

31. Liu, J., Chen, Y., Cao, H., & Zhang, A. (2019). Burden of typical diseases attributed to the sources of PM2.5-bound toxic metals in Beijing: An integrated approach to source apportionment and QALYs. *Environment International, 131*, 105041. doi:https://doi.org/10.1016/j.envint.2019.105041
32. McMurtry, A. (2021). Spain to send COVID-19 vaccine to Andorra. *Andorra is Wealthier per capita, but spain says it is impossible for small cuntires to sign contracts for vaccines.* Retrieved from http://www.ac.com.tr/en/europe/spain-to-send-covid-19-vaccine-to-andorra/2115356
33. Mensah Abrampah N, S. S., Hirschhorn LR (2018). Quality improvement and emerging global health priorities. *Int J Qual Health Care, 30*(5-9).
34. Mihai G. Netea, J. W. M. v. d. M., Reinout van Crevel (2020). BCG vaccination in health care providers and the protection against COVID-19. *The Journal of Clinical Investigation, 131*(2).
35. Motta, M. (2021). Can a COVID-19 vaccine live up to Americans' expectations? A conjoint analysis of how vaccine characteristics influence vaccination intentions. *Social Science & Medicine, 272*, 113642. doi:https://doi.org/10.1016/j.socscimed.2020.113642
36. New SARS-CoV-2 test is a simple, c.-e., and efficient alternative for SARS-CoV-2 testing. (2020). New SARS-CoV-2 test is a simple, cost-effective, and efficient alternative for SARS-CoV-2 testing. Retrieved from https://www.sciencedaily.com/releases/2020/11/201117122842.htm
37. New York Times. (2020). Retrieved from https://scholar.google.com/scholar?q=New%20York%20Times.%202020
38. Olubiyi, O. O., Olagunju, M., Keutmann, M., Loschwitz, J., & Strodel, B. (2020). High Throughput Virtual Screening to Discover Inhibitors of the Main Protease of the Coronavirus SARS-CoV-2. . *Molecules, 25, 3193*.
39. Oronsky, B., Gruber, H. E., Reiners, W., & Reid, T. R. (2021). A Short Discussion About The SARS-CoV-2 mRNA-1273 Vaccine. *International Journal of Infectious Diseases*. doi:https://doi.org/10.1016/j.ijid.2021.01.048
40. *Overview of the implementation of COVID-19 vaccination strategies and vaccine deplopment plans in the EU/EEA*. (2021). Retrieved from Stockholm http://www.ecdc.europa.eu/sites/default/files/documents/Overview-of-Covid-19-vaccination-strategies-development-plan-in-the-EU-EEA.pdf
41. Pliskin JS, S. D., Weinstein MC. . Utility functions for life years and health status. *Operations Research, 28*, 206-224.
42. Pruckner, G. J., Schneeweis, N., Schober, T., & Zweimüller, M. (2021). Birth order, parental health investment, and health in childhood. *Journal of Health Economics, 76*, 102426. doi:https://doi.org/10.1016/j.jhealeco.2021.102426
43. Qian, M., Chou, S.-Y., & Lai, E. K. (2020). Confirmatory bias in health decisions: Evidence from the MMR-autism controversy. *Journal of Health Economics, 70*, 102284. doi:https://doi.org/10.1016/j.jhealeco.2019.102284
44. Ralev, R. (2021). Slovenia to get 2 mln doses of Pfizer, Moderna vaccines in 2021 - PM. Retrieved from https://seenews.com/news/slovenia-to-get-2-mln-doses-of-pfizer-moderna-vaccines-in-2021-pm-727690
45. Randad, P. R., Pisanic, N., Kruczynski, K., Manabe, Y. C., Thomas, D., Pekosz, A., . . . Heaney, C. D. (2020). COVID-19 serology at population scale: SARS-CoV-2-specific antibody responses in saliva. *medRxiv*, 2020.2005.2024.20112300. doi:10.1101/2020.05.24.20112300
46. Rydyznski Moderbacher, C., Ramirez, S. I., Dan, J. M., Grifoni, A., Hastie, K. M., Weiskopf, D., . . . Crotty, S. (2020). Antigen-Specific Adaptive Immunity to SARS-CoV-2 in Acute COVID-19 and Associations with Age and Disease Severity. *Cell, 183*(4), 996-1012.e1019. doi:10.1016/j.cell.2020.09.038
47. Sajid, I. China's Sinovac gets $500M funding for COVID-19 vaccine. *Company says its coronavirus vaccine reached critical milestones in clinical trials in Asia and Latin America*. Retrieved from https://www.aa.com.tr/en/asia-pacific/china-s-sinovac-gets-500m-funding-for-covid-19-vaccine/2067846
48. Schive, K. (2020). COVID-19 (coronavirus disease 2019) January 2020 updates. Retrieved from https://medical.mit.edu/COVID-19/jan2020-updates
49. Sekar, K. (January 11, 2021). *Funding for COVID-19 Vaccines: An Overview*. Retrieved from Congressional Research Service, Information the legislative debate since 1914: https://crsreports.congress.gov/product/pdf/IN/IN11556?__cf_chl_jschl_tk__=53d3e124861d7f12f7b3b1e3e083b7a70bbb3559-1612332942-0-AUO5tiCCNG6mbNik_IacqXbg-

1faglaDJHC2JuDm_DrWt41SizkpNJFybJo-g16mR-wznMXB_Ilo8YTnC_BTW3Raz7Tv3HgJX3kWmsdA8AXA9OAzPKEPNGfeKpL7jy1E2-dXhhmhQd7rVA-TNr8oDRaUfcOmYcxCmy9Qie3-yLuFrxojF04Y1QDVUa5hwQ796pPCtInVzi6NAZphx8wKfOw8bDYxbIxvGB3bnXfR0x_EwPqpQAL2ZsIs2D6U6nxHvNBm2Z-MUROfnSHiz9nwDyLsnU4E-v3pKsEspC8kU1eAJ_lBqZeXOuCOO7gZY0AE9iFkwe5CdAlNtH--1FwTnJw

50. Sevinclidir, P. (2021, February 3). Turkey's COVID vaccination plan depends entirley on a Chinese vaccine with mixed trial result. *CBS News*. Retrieved from http://www.cbsnews.com/news/turkey-covid-vaccine-plan-depends-chinese-sinovac-vaccine-mixed-trial-results/
51. Staff, P. (2021, 20 January). 12,637 Covid-19 vaccine doses given on Guam *The Guam Post daily* Retrieved from http://www.postguam.com/news/local/12-637-covid-19-vaccine-doses-given-on-guam/article_8525faee-565a-11eb-88b4-479055c195d6.html
52. Terry, M. (2021). UPDATED Comparing COVID-19 Vaccines: Timelines, Types and Prices. Retrieved from https://www.biospace.com/article/comparing-covid-19-vaccines-pfizer-biontech-moderna-astrazeneca-oxford-j-and-j-russia-s-sputnik-v/
53. Turkey exceeds 2 million COVID-19 vaccination (2021, Feb 01). *Daily Sabah*. Retrieved from http://www.dailysabah.com/turkey/turkeyexceeds-2-million-covid-19-vaccination/news
54. Unurzul.M. (2021). Mongolia registers three coronavirus vaccine. Retrieved from http://montsame.mn/en/read/249481
55. Weintraub, K. (2020). Moderna's candidate COVID-19 vaccine looks to protect 94.5% of those who get it, trial shows. *How Pfizer and Moderna's vaccines differ.* Retrieved from https://www.usatoday.com/story/news/nation/2020/11/16/moderna-covid-19-vaccine-trial-effective-candidate/6307647002/
56. WorldOmeter. (July 18, 2020). Countries where COVID-19 has spread. Retrieved from https://www.worldometers.info/coronavirus/countries-where-coronavirus-has-spread/

Figures

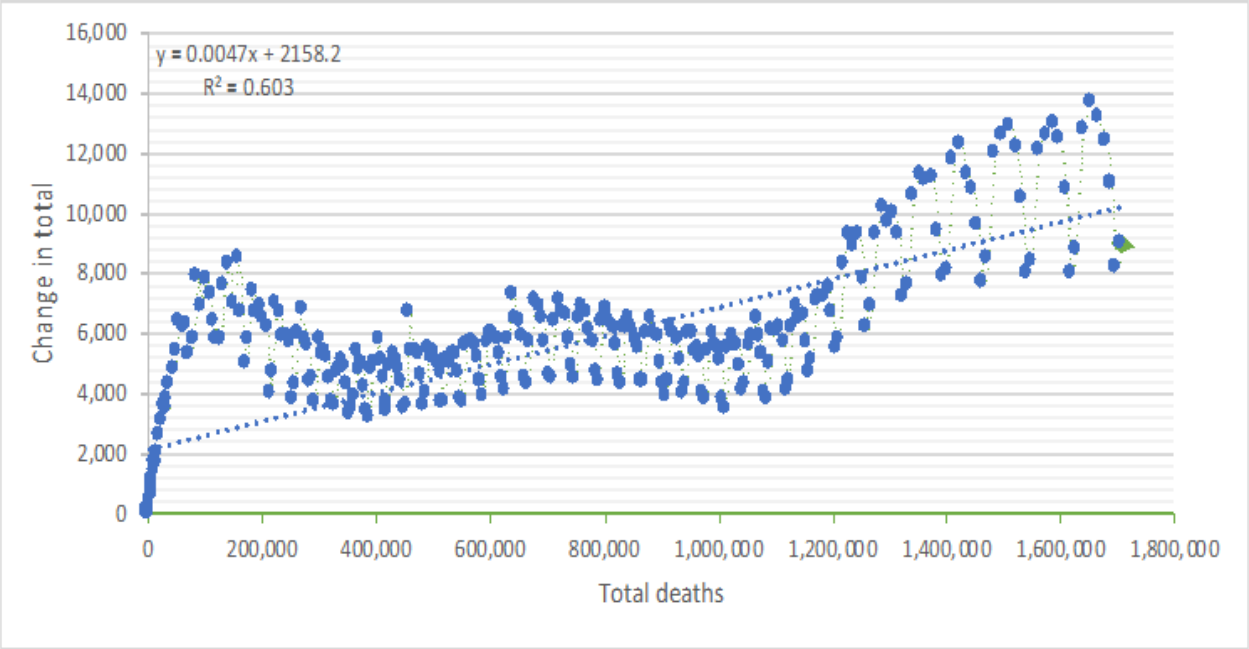

Figure 1

Coronavirus death toll Source: https://www.worldometers.info/coronavirus/coronavirus-death-toll/

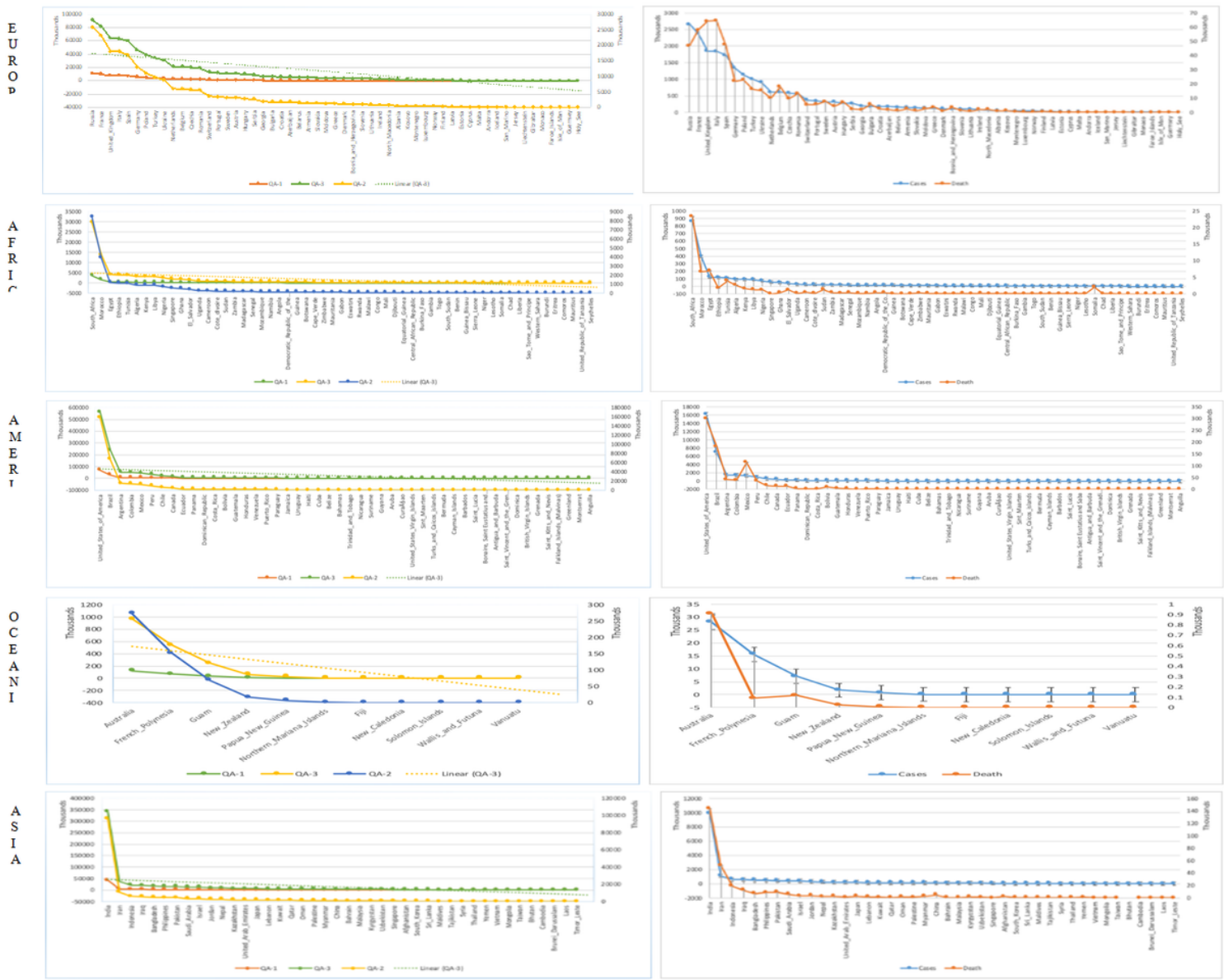

Figure 2

Contents QALYs

Groups	Total number of countries in regions	Number of countries	Region	Countries	Cases	Deaths	Death ratio	Population pop Data2019	Cumulative_number_for_14_days_of_COVID-19_cases_per_100000. December	Years			Utility value ($)			QALYs ($)			Difference of QALYs		Value of statistics life ($)		
										Partial healthy	Healthy	Perfect healthy	MD-1 (Partial utility) SARS-CoV-2 (GBS price IPO)	MD-2 (Utility) Pfizer (BNT162b2)	MD-3 (Additional utility) mRNA-1273 (Moderna's)	QA-1	QA-2	QA-3	(QA-3)-(QA-1)	(QA-3)-(QA-2)	VSL-1	VSL-2	VSL-3
GP-1	1	1	Europe	Russia	2653928	46941	0.017687	145872260	263.6635643	0.25	0.5	1	17	19.5	34.5	11,279,194.00	25,875,798.00	91,560,516.00	80,281,322.00	65,684,718.00	9.42	18.84	37.68
	2	2	Europe	France	2376852	57911	0.024365	67012883	236.3262001	0.25	0.5	1	17	19.5	34.5	10,101,621.00	23,174,307.00	82,001,394.00	71,899,773.00	58827087	10.5181	21.0362	42.0725
	3	3	Europe	United_Kingdom	1849403	64170	0.034698	66647112	348.2161388	0.25	0.5	1	17	19.5	34.5	7,859,962.75	18,031,679.25	63,804,403.50	55944440.75	45772724.25	13.5179	27.0358	54.0715
	4	4	Europe	Italy	1843712	64520	0.034995	60359546	428.3233012	0.25	0.5	1	17	19.5	34.5	7,835,776.00	17,976,192.00	63,608,064.00	55772288	45631872	13.5596	27.1192	54.2384
	5	5	Europe	Spain	1730575	47624	0.027519	46937060	218.0941883	0.25	0.5	1	17	19.5	34.5	7,354,943.75	16,873,106.25	59,704,837.50	52349893.75	42831731.25	14.4461	28.8921	57.7843
	6	6	Europe	Germany	1337078	21975	0.016435	83019213	341.1366957	0.25	0.5	1	17	19.5	34.5	5,682,581.50	13,036,510.50	46,129,191.00	40446609.5	33092680.5	18.6975	37.3950	74.7900
	7	7	Europe	Poland	1135676	22864	0.020133	37972812	396.6021795	0.25	0.5	1	17	19.5	34.5	4,826,623.00	11,072,841.00	39,180,822.00	34354199	28107981	22.0133	44.0266	88.0533
	8	1	USA	United_States_of_America	16256754	299177	0.018403	329064917	873.2115919	0.25	0.5	1	17	19.5	34.5	69,091,204.50	158,503,351.50	560,858,013.00	491766808.5	402354661.5	1.5378	3.0756	6.1513
	9	2	USA	Brazil	6901952	181402	0.026283	211049519	278.2342281	0.25	0.5	1	17	19.5	34.5	29,333,296.00	67,294,032.00	238,117,344.00	208784048	170823312	3.6222	7.2443	14.4887
	10	3	USA	Argentina	1498160	40766	0.027211	44780675	177.2327014	0.25	0.5	1	17	19.5	34.5	6,367,180.00	14,607,060.00	51,686,520.00	45319340	37079460	16.6871	33.3743	66.7485
	11	4	USA	Colombia	1425774	39053	0.027391	50339443	233.2127513	0.25	0.5	1	17	19.5	34.5	6,059,539.50	13,901,296.50	49,189,203.00	43129663.5	35287906.5	17.5343	35.0687	70.1373
	12	5	USA	Mexico	1250044	113953	0.091159	127575529	112.0692982	0.25	0.5	1	17	19.5	34.5	5,312,687.00	12,187,929.00	43,126,518.00	37813831	30938589	19.9993	39.9986	79.9972
	13	1	Asia	India	9884100	143355	0.014504	1366417756	33.10912772	0.25	0.5	1	17	19.5	34.5	42,007,425.00	96,369,975.00	341,001,450.00	298994025	244631475	2.5293	5.0586	10.1173
	14	2	Asia	Iran	1108269	52196	0.047097	82913893	192.3923654	0.25	0.5	1	17	19.5	34.5	4,710,143.25	10,805,622.75	38,235,280.50	33525137.25	27429657.75	22.5577	45.1154	90.2308

Figure 3

QALYs estimation (GP-1)

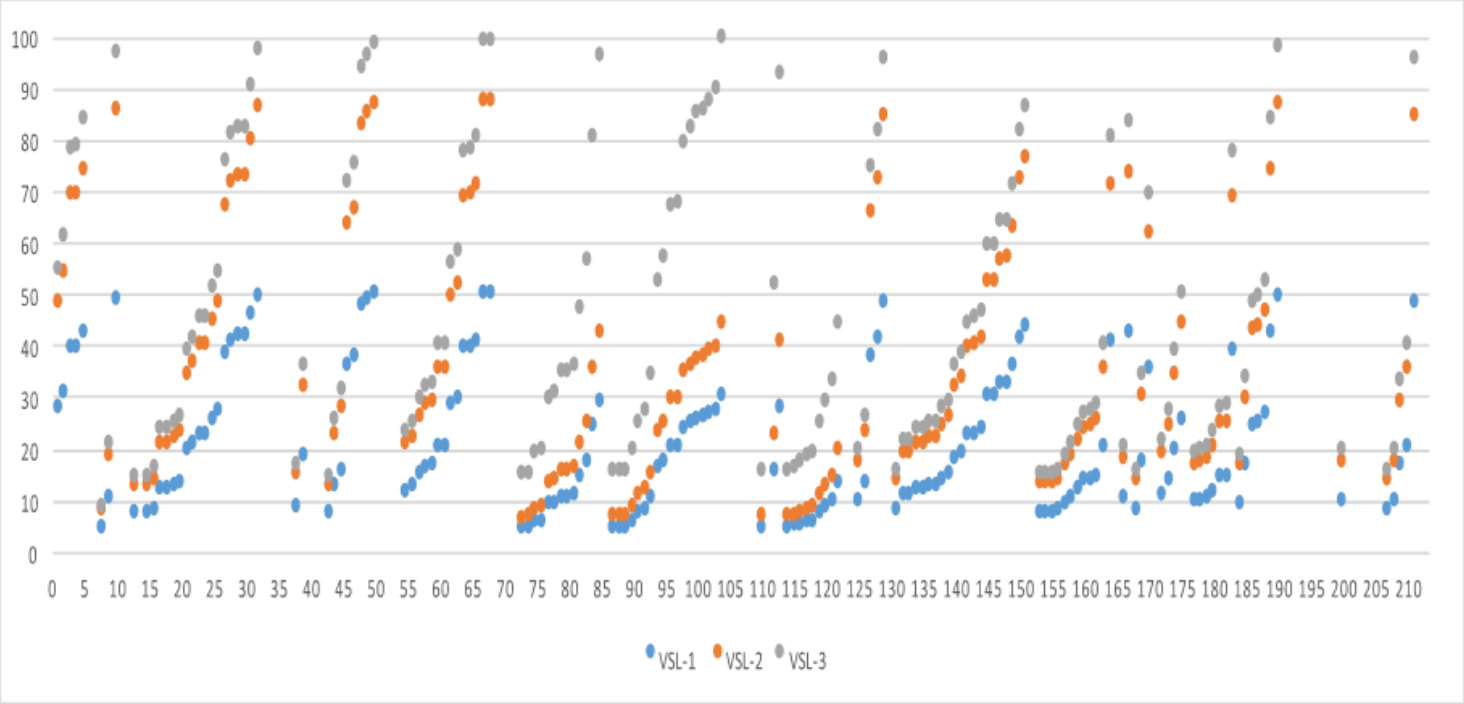

Figure 4

Contribution of funding

Groups	Total number of countries in region	Number of countries	Region	Countries	Cases	Deaths	Death ratio	Population pop Data2019	Cumulative_number_for_14_days_of_COVID-19_cases_per_100000. December	Years			Utility value ($)			QALYs ($)			Difference of QALYs		Value of statistics life ($)		
										Partial health	Healthy	Perfect health	MD-1 (Partial utility) SARS-CoV-2 (GBS-price IPO)	MD-2 (Utiltiy) Pfizer (BNT162b2)	MD-3 (Additional utility) mRNA-1273 (Moderna's)	QA-1	QA-2	QA-3	(QA-3)-(QA-1)	(QA-3)-(QA-2)	VSL-1	VSL-2	VSL-3
GP-2	1	1	Europe	Turkey	995471	16199	0.016273	82003882	499.2202686	0.25	0.5	1	17	19.5	34.5	4,230,751.75	9,705,842.25	34,343,749.50	30112997.75	24637907.25	2.5114	5.0227	10.0455
	2	2	Europe	Ukraine	900666	15247	0.016929	43993643	404.5743609	0.25	0.5	1	17	19.5	34.5	3,827,830.50	8,781,493.50	31,072,977.00	27245146.5	22291483.5	2.7757	5.5514	11.1029
	3	3	Europe	Netherlands	612746	10034	0.016375	17282163	546.6503238	0.25	0.5	1	17	19.5	34.5	2,604,170.50	5,974,273.50	21,139,737.00	18535566.5	15165463.5	4.0800	8.1600	16.3200
	4	4	Europe	Belgium	608001	17951	0.029525	11455519	268.2375194	0.25	0.5	1	17	19.5	34.5	2,584,004.25	5,928,009.75	20,976,034.50	18392030.25	15048024.75	4.1118	8.2237	16.4473
	5	5	Europe	Czechia	581079	9609	0.016536	10649800	576.1234953	0.25	0.5	1	17	19.5	34.5	2,469,585.75	5,665,520.25	20,047,225.50	17577639.75	14381705.25	4.3023	8.6047	17.2094
	6	6	Europe	Romania	556335	13385	0.024059	19414458	436.7827317	0.25	0.5	1	17	19.5	34.5	2,364,423.75	5,424,266.25	19,193,557.50	16829133.75	13769291.25	4.4937	8.9874	17.9748
	7	7	Europe	Switzerland	372329	5378	0.014444	8544527	647.3383489	0.25	0.5	1	17	19.5	34.5	1,582,398.25	3,630,207.75	12,845,350.50	11262952.25	9215142.75	6.7145	13.4290	26.8580
	8	8	Europe	Portugal	348744	5559	0.01594	10276617	524.9295561	0.25	0.5	1	17	19.5	34.5	1,482,162.00	3,400,254.00	12,031,668.00	10549506	8631414	7.1686	14.3372	28.6743
	9	9	Europe	Sweden	320098	7514	0.023474	10230185	738.7549688	0.25	0.5	1	17	19.5	34.5	1,360,416.50	3,120,955.50	11,043,381.00	9682964.5	7922425.5	7.8101	15.6202	31.2404
	10	10	Europe	Austria	320036	4400	0.013748	8858775	472.4580995	0.25	0.5	1	17	19.5	34.5	1,360,153.00	3,120,351.00	11,041,242.00	9681089	7920891	7.8116	15.6232	31.2465
	11	11	Europe	Hungary	283870	7130	0.025117	9772756	683.000783	0.25	0.5	1	17	19.5	34.5	1,206,447.50	2,767,732.50	9,793,515.00	8587067.5	7025782.5	8.8068	17.6137	35.2274
	12	12	Europe	Serbia	266432	2331	0.008749	6963764	1396.055352	0.25	0.5	1	17	19.5	34.5	1,132,336.00	2,597,712.00	9,191,904.00	8059568	6594192	9.3833	18.7665	37.5330
	13	13	Europe	Georgia	191063	1839	0.009625	3996762	1388.098666	0.25	0.5	1	17	19.5	34.5	812,017.75	1,862,864.25	6,591,673.50	5779655.75	4728809.25	13.0847	26.1694	52.3388
	14	14	Europe	Bulgaria	179449	5688	0.031697	7000039	528.0399152	0.25	0.5	1	17	19.5	34.5	762,658.25	1,749,627.75	6,190,990.50	5428332.25	4441362.75	13.9315	27.8631	55.7261
	15	15	Europe	Croatia	175886	2640	0.01501	4076246	1208.808381	0.25	0.5	1	17	19.5	34.5	747,515.50	1,714,888.50	6,068,067.00	5320551.5	4353178.5	14.2138	28.4275	56.8550
	16	16	Europe	Azerbaijan	175874	1922	0.010928	10047719	574.0506875	0.25	0.5	1	17	19.5	34.5	747,464.50	1,714,771.50	6,067,653.00	5320188.5	4352881.5	14.2147	28.4294	56.8589
	17	17	Europe	Belarus	160295	1263	0.007879	9452409	267.5191055	0.25	0.5	1	17	19.5	34.5	681,253.75	1,562,876.25	5,530,177.50	4848923.75	3967301.25	15.5962	31.1925	62.3850
	18	18	Europe	Armenia	148682	2503	0.016835	2957728	458.3923877	0.25	0.5	1	17	19.5	34.5	631,898.50	1,449,649.50	5,129,529.00	4497630.5	3679879.5	16.8144	33.6288	67.2576
	19	19	Europe	Slovakia	132984	1175	0.008836	5450421	499.9797263	0.25	0.5	1	17	19.5	34.5	565,182.00	1,296,594.00	4,587,948.00	4022766	3291354	18.7993	37.5985	75.1970
	20	20	Europe	Moldova	126518	2572	0.020329	4043258	482.3090686	0.25	0.5	1	17	19.5	34.5	537,701.50	1,233,550.50	4,364,871.00	3827169.5	3131320.5	19.7600	39.5201	79.0401
	21	21	Europe	Greece	124534	3625	0.029109	10724599	189.349737	0.25	0.5	1	17	19.5	34.5	529,269.50	1,214,206.50	4,296,423.00	3767153.5	3082216.5	20.0748	40.1497	80.2994
	22	22	Europe	Denmark	109758	941	0.008573	5806081	523.692315	0.25	0.5	1	17	19.5	34.5	466,471.50	1,070,140.50	3,786,651.00	3320179.5	2716510.5	22.7774	45.5548	91.1095
	23	23	Europe	Bosnia_and_Herzegovina	101117	3336	0.032991	3300998	416.3286376	0.25	0.5	1	17	19.5	34.5	429,747.25	985,890.75	3,488,536.50	3058789.25	2502645.75	24.7238	49.4477	98.8953
	24	1	south Africa	South_Africa	860964	23276	0.027035	58558267	125.1095768	0.25	0.5	1	17	19.5	34.5	3,659,097.00	8,394,399.00	29,703,258.00	26044161	21308859	2.9037	5.8074	11.6149
	25	2	south Africa	Morocco	399609	6624	0.016576	36471766	125.5930409	0.25	0.5	1	17	19.5	34.5	1,698,338.25	3,896,187.75	13,786,518.50	12088172.25	9890322.75	6.2561	12.5122	25.0245
	26	3	south Africa	Egypt	121575	6920	0.05692	100388076	6.01067402	0.25	0.5	1	17	19.5	34.5	516,693.75	1,185,356.25	4,194,337.50	3677643.75	3008981.25	20.5634	41.1269	82.2538
	27	4	south Africa	Ethiopia	116769	1806	0.015466	112078727	6.45528388	0.25	0.5	1	17	19.5	34.5	496,268.25	1,138,497.75	4,028,530.50	3532262.25	2890032.75	21.4098	42.8196	85.6392
	28	5	south Africa	Tunisia	111361	3894	0.034967	11694721	129.2035954	0.25	0.5	1	17	19.5	34.5	473,284.25	1,085,769.75	3,841,954.50	3368670.25	2756184.75	22.4495	44.8990	89.7980
	29	1	USA	Peru	984973	36677	0.037237	32510462	69.03116231	0.25	0.5	1	17	19.5	34.5	4,186,135.25	9,603,486.75	33,981,568.50	29795433.25	24378081.75	2.5381	5.0763	10.1526
	30	2	USA	Chile	571919	15886	0.027777	18952035	113.3862406	0.25	0.5	1	17	19.5	34.5	2,430,655.75	5,576,210.25	19,731,205.50	17300549.75	14154995.25	4.3712	8.7425	17.4850
	31	3	USA	Canada	460743	13431	0.029151	37411038	241.8136594	0.25	0.5	1	17	19.5	34.5	1,958,157.75	4,492,244.25	15,895,633.50	13937475.75	11403389.25	5.4260	10.8520	21.7041
	32	4	USA	Ecuador	202110	13875	0.068651	17373657	57.51811493	0.25	0.5	1	17	19.5	34.5	858,967.50	1,970,572.50	6,972,795.00	6113827.5	5002222.5	12.3695	24.7390	49.4780
	33	5	USA	Panama	193007	3356	0.017388	4246440	665.9225139	0.25	0.5	1	17	19.5	34.5	820,279.75	1,881,818.25	6,658,741.50	5838461.75	4776923.25	12.9529	25.9058	51.8116
	34	6	USA	Dominican_Republic	154692	2361	0.015263	10738957	104.4701082	0.25	0.5	1	17	19.5	34.5	657,441.00	1,508,247.00	5,336,874.00	4679433	3828627	16.1611	32.3223	64.6446
	35	7	USA	Costa_Rica	150947	1895	0.012554	5047561	274.4691941	0.25	0.5	1	17	19.5	34.5	641,524.75	1,471,733.25	5,207,671.50	4566146.75	3735938.25	16.5621	33.1242	66.2484
	36	8	USA	Bolivia	147150	9818	0.061284	11513102	21.95759232	0.25	0.5	1	17	19.5	34.5	625,387.50	1,434,712.50	5,076,675.00	4451287.5	3641962.5	16.9895	33.9789	67.9579
	37	9	USA	Guatemala	129282	4423	0.034212	17581476	41.5835394	0.25	0.5	1	17	19.5	34.5	549,448.50	1,260,499.50	4,460,229.00	3910780.5	3199729.5	19.3376	38.6751	77.3503
	38	10	USA	Honduras	114359	2975	0.026015	9746115	66.3956869	0.25	0.5	1	17	19.5	34.5	486,025.75	1,115,008.25	3,945,385.50	3459359.75	2830385.25	21.8610	43.7220	87.4439
	39	11	USA	Venezuela	107177	949	0.008855	28515829	18.01455606	0.25	0.5	1	17	19.5	34.5	455,502.25	1,044,975.75	3,697,606.50	3242104.25	2652630.75	23.3259	46.6518	93.3036
	40	12	USA	Puerto_Rico	107158	1272	0.01187	2933404	564.6341247	0.25	0.5	1	17	19.5	34.5	455,421.50	1,044,790.50	3,696,951.00	3241529.5	2652160.5	23.3300	46.6601	93.3201
	41	1	Asia	Indonesia	617820	18819	0.03046	270625567	30.87439259	0.25	0.5	1	17	19.5	34.5	2,625,735.00	6,023,745.00	21,314,790.00	18689055	15291045	4.0465	8.0930	16.1859
	42	2	Asia	Iraq	574634	12579	0.02189	39309789	61.55973007	0.25	0.5	1	17	19.5	34.5	2,442,194.50	5,602,681.50	19,824,873.00	17382678.5	14222191.5	4.3506	8.7012	17.4024
	43	3	Asia	Bangladesh	490533	7052	0.014376	163046173	17.25032822	0.25	0.5	1	17	19.5	34.5	2,084,765.25	4,782,696.75	16,923,388.50	14838623.25	12140691.75	5.0965	10.1930	20.3860
	44	4	Asia	Philippines	449400	8733	0.019433	108116622	18.06937697	0.25	0.5	1	17	19.5	34.5	1,909,950.00	4,381,650.00	15,504,300.00	13594350	11122650	5.5630	11.1259	22.2519
	45	5	Asia	Pakistan	440787	8832	0.020037	216565317	19.74600577	0.25	0.5	1	17	19.5	34.5	1,873,344.75	4,297,673.25	15,207,151.50	13333806.75	10909478.25	5.6717	11.3433	22.6867
	46	6	Asia	Saudi_Arabia	359888	6048	0.016805	34268529	8.05403699	0.25	0.5	1	17	19.5	34.5	1,529,524.00	3,508,908.00	12,416,136.00	10886612	8907228	6.9466	13.8932	27.7864
	47	7	Asia	Israel	357859	2999	0.00838	8519373	256.814674	0.25	0.5	1	17	19.5	34.5	1,520,900.75	3,489,125.25	12,346,135.50	10825234.75	8857010.25	6.9860	13.9720	27.9440
	48	8	Asia	Jordan	259614	3365	0.012962	10101697	448.5088001	0.25	0.5	1	17	19.5	34.5	1,103,359.50	2,531,236.50	8,956,683.00	7853323.5	6425446.5	9.6297	19.2594	38.5187
	49	9	Asia	Nepal	248423	1698	0.006835	28608715	57.48248392	0.25	0.5	1	17	19.5	34.5	1,055,797.75	2,422,124.25	8,570,593.50	7514795.75	6148469.25	10.0635	20.1270	40.2539
	50	10	Asia	Kazakhstan	186277	2552	0.0137	18551428	67.22393554	0.25	0.5	1	17	19.5	34.5	791,677.25	1,816,208.75	6,426,556.50	5634879.25	4610355.75	13.4209	26.8417	53.6835
	51	11	Asia	United_Arab_Emirates	184949	617	0.003336	9770526	175.9987129	0.25	0.5	1	17	19.5	34.5	786,033.25	1,803,252.75	6,380,740.50	5594707.25	4577487.75	13.5172	27.0345	54.0690
	52	12	Asia	Japan	179653	2585	0.014389	126860299	25.92852158	0.25	0.5	1	17	19.5	34.5	763,525.25	1,751,616.75	6,198,028.50	5434503.25	4446411.75	13.9157	27.8314	55.6629
	53	13	Asia	Lebanon	146520	1200	0.00819	6855709	285.5430416	0.25	0.5	1	17	19.5	34.5	622,710.00	1,428,570.00	5,054,940.00	4432230	3626370	17.0625	34.1250	68.2501
	54	14	Asia	Kuwait	146218	911	0.00623	4207077	90.13383877	0.25	0.5	1	17	19.5	34.5	621,426.50	1,425,625.50	5,044,521.00	4423094.5	3618895.5	17.0978	34.1955	68.3910
	55	15	Asia	Qatar	140961	240	0.001703	2832071	81.67168125	0.25	0.5	1	17	19.5	34.5	599,084.25	1,374,369.75	4,863,154.50	4264070.25	3488784.75	17.7354	35.4708	70.9416
	56	16	Asia	Oman	126240	1471	0.011652	4974992	55.39707401	0.25	0.5	1	17	19.5	34.5	536,520.00	1,230,840.00	4,355,280.00	3818760	3124440	19.8035	39.6071	79.2142
	57	17	Asia	Palestine	124657	1079	0.008656	4981422	559.4587248	0.25	0.5	1	17	19.5	34.5	529,792.25	1,215,405.75	4,300,666.50	3770874.25	3085260.75	20.0550	40.1101	80.2201
	58	18	Asia	Myanmar	108342	2268	0.020934	54045422	34.88917156	0.25	0.5	1	17	19.5	34.5	460,453.50	1,056,334.50	3,737,799.00	3277345.5	2681464.5	23.0751	46.1502	92.3003

Figure 5

QALYs estimation (GP-2)

Groups	Total number of countries in region	Number of countries	Region	Countries	Cases	Deaths	Death ratio	Population pop Data2019	Cumulative_number_for_14_days_of_COVID-19_cases_per_100000. December	Years			Utility value ($)			QALYs ($)			Difference of QALYs		Value of statistics life ($)		
										Partial health	Healthy	Perfect health	MD-1 (Partial utility) SARS-CoV-2 (GBS-price IPO)	MD-2 (Utiltiy) Pfizer (BNT162b2)	MD-3 (Additional utility) mRNA-1273 (Moderna's)	QA-1	QA-2	QA-3	(QA-3)-(QA-1)	(QA-3)-(QA-2)	VSL-1	VSL-2	VSL-3
GP-3	1	1	Europe	Slovenia	96314	1459	0.015148	2080908	1005.955093	0.25	0.5	1	17	19.5	34.5	409,334.50	939,061.50	3,322,833.00	2913498.5	2383771.5	1.5574	2.5957	10.3827
	2	2	Europe	Lithuania	95021	825	0.008682	2794184	1205.933468	0.25	0.5	1	17	19.5	34.5	403,839.25	926,454.75	3,278,224.50	2874385.25	2351769.75	1.5786	2.6310	10.5240
	3	3	Europe	Ireland	76185	2124	0.02788	4904240	80.42028782	0.25	0.5	1	17	19.5	34.5	323,786.25	742,803.75	2,628,382.50	2304596.25	1885578.75	1.9689	3.2815	13.1259
	4	4	Europe	North_Macedonia	73638	2121	0.028803	2077132	582.2932775	0.25	0.5	1	17	19.5	34.5	312,961.50	717,970.50	2,540,511.00	2227549.5	1822540.5	2.0370	3.3950	13.5799
	5	5	Europe	Albania	48530	1003	0.020668	2862427	380.9704143	0.25	0.5	1	17	19.5	34.5	206,252.50	473,167.50	1,674,285.00	1468032.5	1201117.5	3.0909	5.1515	20.6058
	6	6	Europe	Kosovo	46580	1198	0.025719	1798506	418.2916265	0.25	0.5	1	17	19.5	34.5	197,965.00	454,155.00	1,607,010.00	1409045	1152855	3.2203	5.3671	21.4684
	7	7	Europe	Montenegro	41426	582	0.014049	622182	1051.943001	0.25	0.5	1	17	19.5	34.5	176,060.50	403,903.50	1,429,197.00	1253136.5	1025293.5	3.6209	6.0349	24.1394
	8	8	Europe	Luxembourg	41272	396	0.009595	613894	1188.967476	0.25	0.5	1	17	19.5	34.5	175,406.00	402,402.00	1,423,884.00	1248478	1021482	3.6344	6.0574	24.2295
	9	9	Europe	Norway	40022	387	0.00967	5328212	99.00131601	0.25	0.5	1	17	19.5	34.5	170,093.50	390,214.50	1,380,759.00	1210665.5	990544.5	3.7479	6.2466	24.9863
	10	10	Europe	Finland	30810	453	0.014703	5517919	112.0168672	0.25	0.5	1	17	19.5	34.5	130,942.50	300,397.50	1,062,945.00	932002.5	762547.5	4.8685	8.1142	32.4570
	11	11	Europe	Latvia	25675	349	0.013593	1919968	453.1325522	0.25	0.5	1	17	19.5	34.5	109,118.75	250,331.25	885,787.50	776668.75	635456.25	5.8423	9.7371	38.9484
	12	12	Europe	Estonia	18055	149	0.008253	1324820	453.1181595	0.25	0.5	1	17	19.5	34.5	76,733.75	176,036.25	622,897.50	546163.75	446861.25	8.3079	13.8466	55.3863
	13	13	Europe	Cyprus	15101	78	0.005165	875899	538.6465791	0.25	0.5	1	17	19.5	34.5	64,179.25	147,234.75	520,984.50	456805.25	373749.75	9.9331	16.5552	66.2208
	14	14	Europe	Malta	11101	166	0.014954	493559	273.3209201	0.25	0.5	1	17	19.5	34.5	47,179.25	108,234.75	382,984.50	335805.25	274749.75	13.5123	22.5205	90.0820
	15	1	south Africa	Algeria	92102	2596	0.028186	43053054	22.95075281	0.25	0.5	1	17	19.5	34.5	391,433.50	897,994.50	3,177,519.00	2786085.5	2279524.5	1.6286	2.7144	10.8575
	16	2	south Africa	Kenya	91892	1587	0.01727	52573967	16.31225584	0.25	0.5	1	17	19.5	34.5	390,541.00	895,947.00	3,170,274.00	2779733	2274327	1.6324	2.7206	10.8823
	17	3	south Africa	Libya	90779	1299	0.014309	6777453	123.1878701	0.25	0.5	1	17	19.5	34.5	385,810.75	885,095.25	3,131,875.50	2746064.75	2246780.25	1.6524	2.7539	11.0158
	18	4	south Africa	Nigeria	73175	1197	0.016358	200963603	2.86768346	0.25	0.5	1	17	19.5	34.5	310,993.75	713,456.25	2,524,537.50	2213543.75	1811081.25	2.0499	3.4165	13.6659
	19	5	south Africa	Singapore	58320	29	0.000497	5804343	1.84344723	0.25	0.5	1	17	19.5	34.5	247,860.00	568,620.00	2,012,040.00	1764180	1443420	2.5720	4.2867	17.1468
	20	6	south Africa	Ghana	53014	327	0.006168	30417858	4.75049887	0.25	0.5	1	17	19.5	34.5	225,309.50	516,886.50	1,828,983.00	1603673.5	1312096.5	2.8294	4.7157	18.8629
	21	7	south Africa	El_Salvador	41880	1205	0.028773	6453550	53.84633264	0.25	0.5	1	17	19.5	34.5	177,990.00	408,330.00	1,444,860.00	1266870	1036530	3.5817	5.9694	23.8777
	22	8	south Africa	Uganda	27532	221	0.008027	44269587	16.68639918	0.25	0.5	1	17	19.5	34.5	117,011.00	268,437.00	949,854.00	832843	681417	5.4482	9.0803	36.3214
	23	9	south Africa	Cameroon	25413	443	0.017432	25876387	3.96500485	0.25	0.5	1	17	19.5	34.5	108,005.25	247,776.75	876,748.50	768743.25	628971.75	5.9025	9.8375	39.3499
	24	10	south Africa	Cote_divoire	21680	133	0.006135	25716554	1.43876197	0.25	0.5	1	17	19.5	34.5	92,140.00	211,380.00	747,960.00	655820	536580	6.9188	11.5314	46.1255
	25	11	south Africa	Sudan	21386	1347	0.062985	42813237	8.77999484	0.25	0.5	1	17	19.5	34.5	90,890.50	208,513.50	737,817.00	646926.5	529303.5	7.0139	11.6899	46.7596
	26	12	south Africa	Zambia	18274	367	0.020083	17861034	3.72878748	0.25	0.5	1	17	19.5	34.5	77,664.50	178,171.50	630,453.00	552788.5	452281.5	8.2084	13.6806	54.7226
	27	13	south Africa	Madagascar	17638	258	0.014628	26969306	1.10125192	0.25	0.5	1	17	19.5	34.5	74,961.50	171,970.50	608,511.00	533549.5	436540.5	8.5044	14.1739	56.6958
	28	14	south Africa	Senegal	17075	349	0.020439	16296362	6.1363389	0.25	0.5	1	17	19.5	34.5	72,568.75	166,481.25	589,087.50	516518.75	422606.25	8.7848	14.6413	58.5652
	29	15	south Africa	Mozambique	16954	142	0.008376	30366043	4.41611704	0.25	0.5	1	17	19.5	34.5	72,054.50	165,301.50	584,913.00	512858.5	419611.5	8.8475	14.7458	58.9831
	30	16	south Africa	Namibia	16536	160	0.009676	2494524	87.83238806	0.25	0.5	1	17	19.5	34.5	70,278.00	161,226.00	570,492.00	500214	409266	9.0711	15.1185	60.4741
	31	17	south Africa	Angola	16188	371	0.022918	31825299	3.40923741	0.25	0.5	1	17	19.5	34.5	68,799.00	157,833.00	558,486.00	489687	400653	9.2661	15.4435	61.7742
	32	18	south Africa	Democratic_Republic_of_the_Congo	14512	355	0.024463	86790568	2.08663227	0.25	0.5	1	17	19.5	34.5	61,676.00	141,492.00	500,664.00	438988	359172	10.3363	17.2271	68.9085
	33	19	south Africa	Guinea	13420	79	0.005887	12771246	2.98326412	0.25	0.5	1	17	19.5	34.5	57,035.00	130,845.00	462,990.00	405955	332145	11.1773	18.6289	74.5156
	34	20	south Africa	Botswana	12581	37	0.00296	2303703	108.9116088	0.25	0.5	1	17	19.5	34.5	53,129.25	121,884.75	431,284.50	378155.25	309399.75	11.9990	19.9984	79.9936
	35	21	south Africa	Cape_Verde	11357	110	0.009686	549936	151.1084926	0.25	0.5	1	17	19.5	34.5	48,267.25	110,730.75	391,816.50	343549.25	281085.75	13.2077	22.0129	88.0514
	36	22	south Africa	Zimbabwe	11246	307	0.027299	14645473	8.84915086	0.25	0.5	1	17	19.5	34.5	47,795.50	109,648.50	387,987.00	340191.5	278338.5	13.3381	22.2301	88.9205
	37	23	south Africa	Mauritania	10780	222	0.020594	4525698	49.29626325	0.25	0.5	1	17	19.5	34.5	45,815.00	105,105.00	371,910.00	326095	266805	13.9147	23.1911	92.7644
	38	1	USA	Paraguay	93582	1953	0.020869	7044639	165.7430565	0.25	0.5	1	17	19.5	34.5	397,723.50	912,424.50	3,228,579.00	2830855.5	2316154.5	1.6029	2.6715	10.6858
	39	2	USA	Jamaica	11710	273	0.023313	2948277	33.95203368	0.25	0.5	1	17	19.5	34.5	49,767.50	114,172.50	403,995.00	354227.5	289822.5	12.8096	21.3493	85.3971
	40	1	Oceania	Australia	28031	908	0.032393	25203200	0.54754952	0.25	0.5	1	17	19.5	34.5	119,131.75	273,302.25	967,069.50	847937.75	693767.25	5.3512	8.9187	35.6748
	41	2	Oceania	French_Polynesia	15618	91	0.005827	279285	544.9630306	0.25	0.5	1	17	19.5	34.5	66,376.50	152,275.50	538,821.00	472444.5	386545.5	9.6043	16.0072	64.0287
	42	1	Asia	China	92021	4739	0.051499	1433783692	0.01443732	0.25	0.5	1	17	19.5	34.5	391,089.25	897,204.75	3,174,724.50	2783635.25	2277519.75	1.6301	2.7168	10.8671
	43	2	Asia	Bahrain	89143	348	0.003904	1641164	143.5566464	0.25	0.5	1	17	19.5	34.5	378,857.75	869,144.25	3,075,433.50	2696575.75	2206289.25	1.6827	2.8045	11.2179
	44	3	Asia	Malaysia	83475	415	0.004972	31949789	59.43701224	0.25	0.5	1	17	19.5	34.5	354,768.75	813,881.25	2,879,887.50	2525118.75	2066006.25	1.7969	2.9949	11.9796
	45	4	Asia	Kyrgyzstan	77674	1312	0.016891	6415851	75.85899361	0.25	0.5	1	17	19.5	34.5	330,114.50	757,321.50	2,679,753.00	2349638.5	1922431.5	1.9311	3.2186	12.8743
	46	5	Asia	Uzbekistan	75094	612	0.00815	32981715	6.74313025	0.25	0.5	1	17	19.5	34.5	319,149.50	732,166.50	2,590,743.00	2271593.5	1858576.5	1.9975	3.3292	13.3166
	47	6	Asia	Singapore	58320	29	0.000497	5804343	1.84344723	0.25	0.5	1	17	19.5	34.5	247,860.00	568,620.00	2,012,040.00	1764180	1443420	2.5720	4.2867	17.1468
	48	7	Asia	Afghanistan	49273	1971	0.040002	38041757	9.01377925	0.25	0.5	1	17	19.5	34.5	209,410.25	480,411.75	1,699,918.50	1490508.25	1219506.75	3.0443	5.0738	20.2951
	49	8	Asia	South_Korea	43484	587	0.013499	51225321	18.12189718	0.25	0.5	1	17	19.5	34.5	184,807.00	423,969.00	1,500,198.00	1315391	1076229	3.4495	5.7492	22.9970
	50	9	Asia	Sri_Lanka	32790	152	0.004636	21323734	43.64151232	0.25	0.5	1	17	19.5	34.5	139,357.50	319,702.50	1,131,255.00	991897.5	811552.5	4.5746	7.6243	30.4971
	51	10	Asia	Maldives	13368	48	0.003591	530957	70.4388491	0.25	0.5	1	17	19.5	34.5	56,814.00	130,338.00	461,196.00	404382	330858	11.2208	18.7014	74.8055
	52	11	Asia	Tajikistan	12704	88	0.006927	9321023	5.88991144	0.25	0.5	1	17	19.5	34.5	53,992.00	123,864.00	438,288.00	384296	314424	11.8073	19.6788	78.7154

Figure 6

QALYs estimation (GP-3)

Groups	Total number of countries in region	Number of countries	Region	Countries	Cases	Deaths	Death ratio	Population pop Data2019	Cumulative_number_for_14_days_of_COVID-19_cases_per_100000. December	Years			Utility value ($)			QALYs ($)			Difference of QALYs		Value of statistics life ($)		
										Partial health	Healthy	Perfect health	MD-1 (Partial utility) SARS-CoV-2 (GBS-price IPO)	MD-2 (Utiltiy) Pfizer (BNT162b2)	MD-3 (Additional utility) mRNA-1273 (Moderna's)	QA-1	QA-2	QA-3	(QA-3)-(QA-1)	(QA-3)-(QA-2)	VSL-1	VSL-2	VSL-3
GP-4	1	1	Europe	Andorra	7338	79	0.010766	76177	821.7703506	0.25	0.5	1	17	19.5	34.5	31,186.50	71,545.50	253,161.00	221974.5	181615.5	3.4069	6.8138	13.6277
	2	2	Europe	Iceland	5557	28	0.005039	356991	49.30096277	0.25	0.5	1	17	19.5	34.5	23,617.25	54,180.75	191,716.50	168099.25	137535.75	4.4988	8.9977	17.9953
	3	3	Europe	San_Marino	1947	51	0.026194	34453	1047.804255	0.25	0.5	1	17	19.5	34.5	8,274.75	18,983.25	67,171.50	58896.75	48188.25	12.8403	25.6805	51.3611
	4	4	Europe	Jersey	1779	32	0.017988	107796	789.4541541	0.25	0.5	1	17	19.5	34.5	7,560.75	17,345.25	61,375.50	53814.75	44030.25	14.0528	28.1057	56.2114
	5	5	Europe	Liechtenstein	1514	18	0.011889	38378	627.9639377	0.25	0.5	1	17	19.5	34.5	6,434.50	14,761.50	52,233.00	45798.5	37471.5	16.5125	33.0251	66.0502
	6	6	Europe	Gibraltar	1075	5	0.004651	33706	180.9766807	0.25	0.5	1	17	19.5	34.5	4,568.75	10,481.25	37,087.50	32518.75	26606.25	23.2558	46.5116	93.0233
	7	1	south Africa	Gabon	9330	63	0.006752	2172578	6.3979291	0.25	0.5	1	17	19.5	34.5	39,652.50	90,967.50	321,885.00	282232.5	230917.5	2.6795	5.3591	10.7181
	8	2	south Africa	Eswatini	6768	127	0.018765	1148133	31.18105655	0.25	0.5	1	17	19.5	34.5	28,764.00	65,988.00	233,496.00	204732	167508	3.6939	7.3877	14.7754
	9	3	south Africa	Rwanda	6659	56	0.00841	12626938	5.86048652	0.25	0.5	1	17	19.5	34.5	28,300.75	64,925.25	229,735.50	201434.75	164810.25	3.7543	7.5086	15.0173
	10	4	south Africa	Malawi	6066	187	0.030828	18628749	0.22008993	0.25	0.5	1	17	19.5	34.5	25,780.50	59,143.50	209,277.00	183496.5	150133.5	4.1213	8.2427	16.4853
	11	5	south Africa	Congo	6049	99	0.016366	5380504	5.11104536	0.25	0.5	1	17	19.5	34.5	25,708.25	58,977.75	208,690.50	182982.25	149712.75	4.1329	8.2658	16.5317
	12	6	south Africa	Mali	5814	194	0.033368	19658023	5.87546367	0.25	0.5	1	17	19.5	34.5	24,709.50	56,686.50	200,583.00	175873.5	143896.5	4.3000	8.5999	17.1999
	13	7	south Africa	Djibouti	5728	61	0.010649	973557	5.23852224	0.25	0.5	1	17	19.5	34.5	24,344.00	55,848.00	197,616.00	173272	141768	4.3645	8.7291	17.4581
	14	8	south Africa	Equatorial_Guinea	5185	85	0.016393	1355982	2.35991333	0.25	0.5	1	17	19.5	34.5	22,036.25	50,553.75	178,882.50	156846.25	128328.75	4.8216	9.6432	19.2864
	15	9	south Africa	Central_African_Republic	4936	63	0.012763	4745179	0.48470247	0.25	0.5	1	17	19.5	34.5	20,978.00	48,126.00	170,292.00	149314	122166	5.0648	10.1297	20.2593
	16	10	south Africa	Burkina_Faso	4030	71	0.017618	20321383	5.77716586	0.25	0.5	1	17	19.5	34.5	17,127.50	39,292.50	139,035.00	121907.5	99742.5	6.2035	12.4069	24.8139
	17	11	south Africa	Gambia	3782	123	0.032522	2347696	2.04455773	0.25	0.5	1	17	19.5	34.5	16,073.50	36,874.50	130,479.00	114405.5	93604.5	6.6103	13.2205	26.4410
	18	12	south Africa	Togo	3251	66	0.020301	8032359	3.57568873	0.25	0.5	1	17	19.5	34.5	13,816.75	31,697.25	112,159.50	98342.75	80462.25	7.6899	15.3799	30.7598
	19	13	south Africa	South_Sudan	3206	62	0.019339	11062114	0.87686675	0.25	0.5	1	17	19.5	34.5	13,625.50	31,258.50	110,687.00	96981.5	79348.5	7.7979	15.5958	31.1915
	20	14	south Africa	Benin	3090	44	0.014239	11801151	0.98295497	0.25	0.5	1	17	19.5	34.5	13,132.50	30,127.50	106,605.00	93472.5	76477.5	8.0906	16.1812	32.3625
	21	15	south Africa	Guinea_Bissau	2444	44	0.018003	1920917	1.14528634	0.25	0.5	1	17	19.5	34.5	10,387.00	23,829.00	84,318.00	73931	60489	10.2291	20.4583	40.9165
	22	16	south Africa	Sierra_Leone	2440	75	0.030738	7813207	0.37116641	0.25	0.5	1	17	19.5	34.5	10,370.00	23,790.00	84,180.00	73810	60390	10.2459	20.4918	40.9836
	23	17	south Africa	Niger	2258	80	0.03543	23310719	3.183885	0.25	0.5	1	17	19.5	34.5	9,596.50	22,015.50	77,901.00	68304.5	55885.5	11.0717	22.1435	44.2870
	24	18	south Africa	Lesotho	2250	44	0.019556	2125267	6.63446052	0.25	0.5	1	17	19.5	34.5	9,562.50	21,937.50	77,625.00	68062.5	55687.5	11.1111	22.2222	44.4444
	25	19	south Africa	Somalia	2043	2043	1	15442906	0.86771233	0.25	0.5	1	17	19.5	34.5	8,682.75	19,919.25	70,483.50	61800.75	50564.25	12.2369	24.4738	48.9476
	26	20	south Africa	Chad	1770	102	0.057627	15946882	0.55183201	0.25	0.5	1	17	19.5	34.5	7,522.50	17,257.50	61,065.00	53542.5	43807.5	14.1243	28.2486	56.4972
	27	21	south Africa	Liberia	1676	83	0.049523	4937374	1.64054819	0.25	0.5	1	17	19.5	34.5	7,123.00	16,341.00	57,822.00	50699	41481	14.9165	29.8329	59.6659
	28	22	south Africa	Sao_Tome_and_Principe	1009	7	0.006938	215048	9.30024925	0.25	0.5	1	17	19.5	34.5	4,288.25	9,837.75	34,810.50	30522.25	24972.75	24.7770	49.5540	99.1080
	29	1	USA	Uruguay	9708	92	0.009477	3461731	115.3180302	0.25	0.5	1	17	19.5	34.5	41,259.00	94,653.00	334,926.00	293667	240273	2.5752	5.1504	10.3008
	30	2	USA	Haiti	9565	234	0.024464	11263879	2.67244863	0.25	0.5	1	17	19.5	34.5	40,651.25	93,258.75	329,992.50	289341.25	236733.75	2.6137	5.2274	10.4548
	31	3	USA	Cuba	9423	137	0.014539	11333484	10.49986041	0.25	0.5	1	17	19.5	34.5	40,047.75	91,874.25	325,093.50	285045.75	233219.25	2.6531	5.3062	10.6123
	32	4	USA	Belize	9295	195	0.020979	390351	909.9502755	0.25	0.5	1	17	19.5	34.5	39,503.75	90,626.25	320,677.50	281173.75	230051.25	2.6896	5.3792	10.7585
	33	5	USA	Bahamas	7674	163	0.021241	389486	45.70125755	0.25	0.5	1	17	19.5	34.5	32,614.50	74,821.50	264,753.00	232138.5	189931.5	3.2578	6.5155	13.0310
	34	6	USA	Trinidad_and_Tobago	6879	122	0.017735	1394969	15.6992736	0.25	0.5	1	17	19.5	34.5	29,235.75	67,070.25	237,325.50	208089.75	170255.25	3.6342	7.2685	14.5370
	35	7	USA	Nicaragua	5887	162	0.027518	6545503	1.57359946	0.25	0.5	1	17	19.5	34.5	25,019.75	57,398.25	203,101.50	178081.75	145703.25	4.2466	8.4933	16.9866
	36	8	USA	Suriname	5353	117	0.021857	581363	7.0523924	0.25	0.5	1	17	19.5	34.5	22,750.25	52,191.75	184,678.50	161928.25	132486.75	4.6703	9.3406	18.6811
	37	9	USA	Guyana	5290	155	0.029301	782775	69.49634314	0.25	0.5	1	17	19.5	34.5	22,482.50	51,577.50	182,505.00	160022.5	130927.5	4.7259	9.4518	18.9036
	38	10	USA	Aruba	5049	46	0.009111	106310	198.4761546	0.25	0.5	1	17	19.5	34.5	21,458.25	49,227.75	174,190.50	152732.25	124962.75	4.9515	9.9030	19.8059
	39	11	USA	CuraÃ£ao	3624	11	0.003035	163423	77.0053053	0.25	0.5	1	17	19.5	34.5	15,402.00	35,334.00	125,028.00	109626	89694	6.8985	13.7969	27.5938
	40	12	USA	United_States_Virgin_Islands	1807	23	0.012728	104579	251.4845237	0.25	0.5	1	17	19.5	34.5	7,679.75	17,618.25	62,341.50	54661.75	44723.25	13.8351	27.6702	55.3403
	41	13	USA	Sint_Maarten	1232	26	0.021104	42389	391.6110312	0.25	0.5	1	17	19.5	34.5	5,236.00	12,012.00	42,504.00	37268	30492	20.2922	40.5844	81.1688
	42	1	Oceania	Guam	7106	118	0.016606	167295	172.1509908	0.25	0.5	1	17	19.5	34.5	30,200.50	69,283.50	245,157.00	214956.5	175873.5	3.5182	7.0363	14.0726
	43	2	Oceania	New_Zealand	1740	25	0.014368	4783062	0.83628437	0.25	0.5	1	17	19.5	34.5	7,395.00	16,965.00	60,030.00	52635	43065	14.3678	28.7356	57.4713
	44	1	Asia	Syria	9166	518	0.056513	17070132	8.01985597	0.25	0.5	1	17	19.5	34.5	38,955.50	89,368.50	316,227.00	277271.5	226858.5	2.7275	5.4549	10.9099
	45	2	Asia	Thailand	4237	60	0.014161	69625581	0.37342597	0.25	0.5	1	17	19.5	34.5	18,007.25	41,310.75	146,176.50	128169.25	104865.75	5.9004	11.8008	23.6016
	46	3	Asia	Yemen	2083	606	0.290927	29161922	0.02057478	0.25	0.5	1	17	19.5	34.5	8,852.75	20,309.25	71,863.50	63010.75	51554.25	12.0019	24.0038	48.0077
	47	4	Asia	Vietnam	1397	35	0.025054	96462108	0.05598053	0.25	0.5	1	17	19.5	34.5	5,937.25	13,620.75	48,196.50	42259.25	34575.75	17.8955	35.7910	71.5820

Figure 7

QALYs estimation (GP-4)

Groups	Total number of countries in region	Number of countries	Region	Countries	Cases	Deaths	Death ratio	Population pop Data2019	Cumulative_number_for_14_days_of_COVID-19_cases_per_100000. December	Years			Utility value ($)			QALYs ($)			Difference of QALYs		Value of statistics life ($)		
										Partial health	Healthy	Perfect health	MD-1 (Partial utility) SARS-CoV-2 (GBS-price IPO)	MD-2 (Utiltiy) Pfizer (BNT162b2)	MD-3 (Additional utility) mRNA-1273 (Moderna's)	QA-1	QA-2	QA-3	(QA-3)-(QA-1)	(QA-3)-(QA-2)	VSL-1	VSL-2	VSL-3
GP-5	1	1	Europe	Monaco	668	2	0.002994	33085	181.3510654	0.25	0.5	1	17	19.5	34.5	2,839.00	6,513.00	23,046.00	20207	16533	3.7425	7.4850	14.9701
	2	2	Europe	Faroe_Islands	528	0	0	48677	53.41331635	0.25	0.5	1	17	19.5	34.5	2,244.00	5,148.00	18,216.00	15972	13068	4.7348	9.4697	18.9394
	3	3	Europe	Isle_of_Man	370	25	0.067568	84589	1.18218681	0.25	0.5	1	17	19.5	34.5	1,572.50	3,607.50	12,765.00	11192.5	9157.5	6.7568	13.5135	27.0270
	4	4	Europe	Guernsey	289	13	0.044983	64468	4.65347149	0.25	0.5	1	17	19.5	34.5	1,228.25	2,817.75	9,970.50	8742.25	7152.75	8.6505	17.3010	34.6021
	5	5	Europe	Holy_See	26	0	0	815	0	0.25	0.5	1	17	19.5	34.5	110.50	253.50	897.00	786.5	643.5	96.1538	192.3077	384.6154
	6	1	south Africa	Western_Sahara	766	1	0.001305	582458	0	0.25	0.5	1	17	19.5	34.5	3,255.50	7,468.50	26,427.00	23171.5	18958.5	3.2637	6.5274	13.0548
	7	2	south Africa	Burundi	729	1	0.001372	11530577	0.41628446	0.25	0.5	1	17	19.5	34.5	3,098.25	7,107.75	25,150.50	22052.25	18042.75	3.4294	6.8587	13.7174
	8	3	south Africa	Eritrea	711	0	0	3497117	3.83177768	0.25	0.5	1	17	19.5	34.5	3,021.75	6,932.25	24,529.50	21507.75	17597.25	3.5162	7.0323	14.0647
	9	4	south Africa	Comoros	628	7	0.011146	850891	1.99790572	0.25	0.5	1	17	19.5	34.5	2,669.00	6,123.00	21,666.00	18997	15543	3.9809	7.9618	15.9236
	10	5	south Africa	Mauritius	515	10	0.019417	1269670	1.18264872	0.25	0.5	1	17	19.5	34.5	2,188.75	5,021.25	17,767.50	15578.75	12746.25	4.8544	9.7087	19.4175
	11	6	south Africa	United_Republic_of_Tanzania	509	21	0.041257	58005461	0	0.25	0.5	1	17	19.5	34.5	2,163.25	4,962.75	17,560.50	15397.25	12597.75	4.9116	9.8232	19.6464
	12	7	south Africa	Seychelles	187	0	0	97741	14.32356943	0.25	0.5	1	17	19.5	34.5	794.75	1,823.25	6,451.50	5656.75	4628.25	13.3690	26.7380	53.4759
	13	1	USA	Turks_and_Caicos_islands	769	6	0.007802	38194	54.98245798	0.25	0.5	1	17	19.5	34.5	3,268.25	7,497.75	26,530.50	23262.25	19032.75	3.2510	6.5020	13.0039
	14	2	USA	Bermuda	431	9	0.020882	62508	287.9631407	0.25	0.5	1	17	19.5	34.5	1,831.75	4,202.25	14,869.50	13037.75	10667.25	5.8005	11.6009	23.2019
	15	3	USA	Cayman_Islands	298	2	0.006711	64948	36.95263903	0.25	0.5	1	17	19.5	34.5	1,266.50	2,905.50	10,281.00	9014.5	7375.5	8.3893	16.7785	33.5570
	16	4	USA	Barbados	292	7	0.023973	287021	5.92291156	0.25	0.5	1	17	19.5	34.5	1,241.00	2,847.00	10,074.00	8833	7227	8.5616	17.1233	34.2466
	17	5	USA	Saint_Lucia	275	4	0.014545	182795	9.84709647	0.25	0.5	1	17	19.5	34.5	1,168.75	2,681.25	9,487.50	8318.75	6806.25	9.0909	18.1818	36.3636
	18	6	USA	Bonaire, Saint Eustatius and Saba	173	3	0.017341	25983	46.18404341	0.25	0.5	1	17	19.5	34.5	735.25	1,686.75	5,968.50	5233.25	4281.75	14.4509	28.9017	57.8035
	19	7	USA	Antigua_and_Barbuda	148	4	0.027027	97115	7.20794934	0.25	0.5	1	17	19.5	34.5	629.00	1,443.00	5,106.00	4477	3663	16.8919	33.7838	67.5676
	20	8	USA	Saint_Vincent_and_the_Grenadines	98	0	0	110593	11.75481269	0.25	0.5	1	17	19.5	34.5	416.50	955.50	3,381.00	2964.5	2425.5	25.5102	51.0204	102.0408
	21	9	USA	Dominica	87	0	0	71808	2.78520499	0.25	0.5	1	17	19.5	34.5	369.75	848.25	3,000.50	2631.75	2153.25	28.7356	57.4713	114.9425
	22	10	USA	British_Virgin_Islands	76	1	0.013158	30033	9.98901209	0.25	0.5	1	17	19.5	34.5	323.00	741.00	2,622.00	2299	1881	32.8947	65.7895	131.5789
	23	11	USA	Grenada	69	0	0	112002	24.99955358	0.25	0.5	1	17	19.5	34.5	293.25	672.75	2,380.50	2087.25	1707.75	36.2319	72.4638	144.9275
	24	12	USA	Saint_Kitts_and_Nevis	27	0	0	52834	9.46368298	0.25	0.5	1	17	19.5	34.5	114.75	263.25	931.50	816.75	668.25	92.5926	185.1852	370.3704
	25	13	USA	Falkland_Islands_(Malvinas)	19	0	0	3372	59.31198102	0.25	0.5	1	17	19.5	34.5	80.75	185.25	655.50	574.75	470.25	131.5789	263.1579	526.3158
	26	14	USA	Greenland	19	0	0	56660	1.76491352	0.25	0.5	1	17	19.5	34.5	80.75	185.25	655.50	574.75	470.25	131.5789	263.1579	526.3158
	27	15	USA	Montserrat	13	1	0.076923	4991	0	0.25	0.5	1	17	19.5	34.5	55.25	126.75	448.50	393.25	321.75	192.3077	384.6154	769.2308
	28	16	USA	Anguilla	10	0	0	14872	40.34427111	0.25	0.5	1	17	19.5	34.5	42.50	97.50	345.00	302.5	247.5	250.0000	500.0000	1000.0000
	29	1	Oceania	Papua_New_Guinea	725	8	0.011034	8776119	0.79761908	0.25	0.5	1	17	19.5	34.5	3,081.25	7,068.75	25,012.50	21931.25	17943.75	3.4483	6.8966	13.7931
	30	2	Oceania	Northern_Mariana_Islands	113	2	0.017699	57213	12.23498156	0.25	0.5	1	17	19.5	34.5	480.25	1,101.75	3,898.50	3418.25	2796.75	22.1239	44.2478	88.4956
	31	3	Oceania	Fiji	46	2	0.043478	889955	0.44946093	0.25	0.5	1	17	19.5	34.5	195.50	448.50	1,587.00	1391.5	1138.5	54.3478	108.6957	217.3913
	32	4	Oceania	New_Caledonia	36	0	0	282757	1.41464225	0.25	0.5	1	17	19.5	34.5	153.00	351.00	1,242.00	1089	891	69.4444	138.8889	277.7778
	33	5	Oceania	Solomon_Islands	17	0	0	669821	0	0.25	0.5	1	17	19.5	34.5	72.25	165.75	586.50	514.25	420.75	147.0588	294.1176	588.2353
	34	6	Oceania	Wallis_and_Futuna	3	0	0	0	0	0.25	0.5	1	17	19.5	34.5	12.75	29.25	103.50	90.75	74.25	833.3333	1666.6667	3333.3333
	35	7	Oceania	Vanuatu	1	0	0	299882	0	0.25	0.5	1	17	19.5	34.5	4.25	9.75	34.50	30.25	24.75	########	5000.0000	########
	36	1	Asia	Mongolia	912	0	0	3225166	3.75174487	0.25	0.5	1	17	19.5	34.5	3,876.00	8,892.00	31,464.00	27588	22572	2.7412	5.4825	10.9649
	37	2	Asia	Taiwan	740	7	0.009459	23773881	0.27340929	0.25	0.5	1	17	19.5	34.5	3,145.00	7,215.00	25,530.00	22385	18315	3.3784	6.7568	13.5135
	38	3	Asia	Bhutan	438		0	763094	5.50390909	0.25	0.5	1	17	19.5	34.5	1,861.50	4,270.50	15,111.00	13249.5	10840.5	5.7078	11.4155	22.8311
	39	4	Asia	Cambodia	359	0	0	16486542	0.21835992	0.25	0.5	1	17	19.5	34.5	1,525.75	3,500.25	12,385.50	10859.75	8885.25	6.9638	13.9276	27.8552
	40	5	Asia	Brunei_Darussalam	152	1	0.006579	433296	0.46157823	0.25	0.5	1	17	19.5	34.5	646.00	1,482.00	5,244.00	4598	3762	16.4474	32.8947	65.7895
	41	6	Asia	Laos	41	0	0	7169456	0.02785612	0.25	0.5	1	17	19.5	34.5	174.25	399.75	1,414.50	1240.25	1014.75	60.9756	121.9512	243.9024
	42	7	Asia	Timor_Leste	31	0	0	1293120	0.07733234	0.25	0.5	1	17	19.5	34.5	131.75	302.25	1,069.50	937.75	767.25	80.6452	161.2903	322.5806

Figure 8

QALYs estimation (GP-5)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- COVID20210603.xlsx