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REVIEW ARTICLE

Epidemiological and statistical analysis of an island nation of Mauritius in curbing COVID-19: A narrative review

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ABSTRACT

Introduction:
COVID-19 has spread across the entire planet, and multiple countries are experiencing their second and third wave of COVID-19 infections. The study's objective is to determine the approaches and methods implemented by Mauritius to control the transmission of COVID-19, which resulted in the flattening of the curve.

Methods:
A systematic search was undertaken using Pubmed, Pubmed Central, Embase, Trip, Google Scholar databases and the COVID-19 statistics-ministry of health and wellness, Mauritius, from January 15, 2020, to June 02, 2020.

Results:
As soon as case 0 was confirmed on March 18, 2020, contact tracing began. Within four days, the country went into a complete sanitary lockdown. A series of measures including legal legislation, general hygiene and sanitary protocols were issued by the government. International borders were closed. The 11th of May 2020 marked a great victory for the Republic of Mauritius as 335 patients had completely recovered, and only ten deaths were recorded.

Conclusion:
The most important strategy employed was the implementation of an early and stringent lockdown. The measures are taken by the government, its implementation and the adherence of the population to these measures played a more significant role in controlling the outbreak.

Keywords
Indian Ocean islands, Mauritius, Novel Coronavirus 2019, Public health, SARS-CoV-2

Introduction

COVID-19 has spread across the entire planet, and multiple countries are experiencing their second and third wave of COVID-19 infections. The novelty and rapidity of the spread of the virus make the control thereof a logistical nightmare. The key to reducing the impact of the current situation lies in applying strategies that have proven to be fruitful. One such strategy has been applied by the island nation of Mauritius and has paid great dividends. Mauritius belongs to the African continent. It has an area of 2030 km^2 with approximately 1.2 million and a population density of 626/ km^2. The World Health Organization declared COVID-19 a pandemic on March 11, 2020. [1] COVID-19 is caused by the Severe Acute Respiratory Syndrome Corona Virus -2 (SARS-CoV-2). [2] There have been previous epidemics attributed to the coronavirus, namely the Middle East Respiratory Syndrome Corona Virus (MERS-CoV) and Severe Acute Respiratory Syndrome Corona Virus (SARS-CoV). Still, in contrast, the COVID-19 pandemic differs from these by having a high rate of transmission and infectivity with a low mortality rate. [3] This high transmissibility led to COVID-19 being declared an international health concern by WHO on January 30, 2020. [1]

Research shows that the SARS-CoV-2 virus is transmitted from person to person by air droplets, fomites and direct contact. The basic reproduction number, which is denoted by R0 is the measure of the virus's transmissibility. The epidemiological definition of R0 is the average number of secondary infections caused by an infected individual without interventions and use of a vaccine. Majumder et al. used the IDEA model based on the phenomenological method to estimate the R0 and calculated it between 2.0 to 3.3. [4] An R0 of more than 1 indicates a high potential of the virus to cause an epidemic or pandemic. [5]

Considering the virus's high transmissibility, it became important to calculate the risk of exposure to various countries. ROE (Risk of Exposure) in the African countries was estimated to range from 0.002 - 0.461. Via the use of a mathematical model which factored in the gathering factor (gf); weather factor (wf); the distribution factor (df); and the sanitation and hygiene practices (shf). Additionally, the vulnerability of the population was also considered. Mauritius had the highest risk of exposure equating to 0.461, and the total number of projected infections was estimated to be 1,097,013. [6]

In Mauritius, the virus entered through cruise ship workers and a traveler from The United Kingdom. [7] The first case of COVID-19 was confirmed in Mauritius on the March 18, 2020. Since then, 335 cases were detected up until June 03, 2020 with a total of 10 deaths being recorded. The total number of tests conducted amounted to 129,768, out of which 30347 were PCR and 99421 were rapid antigen tests. [8] Mauritius was the second African country that managed to break the pattern of community transmission. [9] In this study we intend to find out the measures and approaches used by Mauritius, which created a barrier for the transmission of COVID-19 resulted in the flattening of the curve; by drawing out a comparison with other countries to discover the factors that led to the control of the outbreak.

Methods

An extensive literature review was done using various databases viz. Pubmed, Pubmed Central, Embase, Trip, Google Scholar databases, COVID-19 statistics-ministry of health and wellness, COVID-19: Communiqués, the official website of Government of Mauritius and news websites from January 15, 2020, till June 02, 2020. Since then, there were no new cases via community transmission. Using global health security index (GHS), which assessed health security capabilities across countries. A combination of Keywords "COVID-19", OR "SARS-CoV-2", OR "Coronavirus", OR "Global" AND "Mauritius" were used during the literature survey.

Results

Mauritius is a small island with a population density of 626/km^2 and is therefore very prone to epidemics. [10] Factors that led to the control of the COVID-19 outbreak were as follows:

Strategies adopted by the Government of Mauritius

Mauritius started screening its incoming passengers at the airport. This screening started on January 22, 2020. By January 29, 2020, passengers with high body temperature readings and passengers coming from high-risk countries were divided. There were three cases, out of which two were cruise ship workers aged 21 and 25, respectively, while one was a traveler from the United Kingdom. [7] The government issued a series of measures including legal legislation and general hygiene and sanitary protocols to control the spread of the novel COVID-19 virus.

These included the state of emergency regulations, curfew orders, wage assistance schemes, The COVID-19 Solitary fund, The COVID-19 projects developmental fund, sanitary measures and deadline extensions. The state of emergency regulations and curfew orders allowed for the isolation and or quarantine of individuals. It provided powers to the police to enforce the compliance of the public and restrict the movement of persons and business operations, respectively. Wage assistance schemes and time extensions ensured payment of employees and gave leniency for deadlines. The COVID-19 funds provided the finances required for the programs and schemes related to COVID-19 and provided financial assistance to the organizations' affected most severely by COVID-19. The Sanitary measures included wearing masks, social distancing, and the liberty of punishment to those found guilty of not following these rules and regulations. These legislations also granted the Prime Minister (PM) the power to prohibit entry of aircraft and ships and the power to order a complete lockdown. [11]

Timeline of COVID-19 in Mauritius

As soon as the cases were detected on March 19, 2020, the country closed its schools, colleges, and public places. International borders were also closed. The contact tracing of the British traveler also began. [12] By March 24, 2020, there were 24 new cases, an increase of 21 new cases. The first two deaths were reported on March 25, 2020. By March 23, 2020, the country had gone into a complete sanitary lockdown that included supermarkets' closing. As per the curfew order mentioned earlier, persons were not allowed to be outdoors between 1800hrs to 0600hrs. Special permission was required by the Commissioner of Police to travel from work to one's residence and vice versa. Persons not adhering to the rules would be committing an offence and were liable to a fine of not more than 500 Mauritian rupees (MUR) and imprisonment of up to 6 months on conviction. [13] The Special support unit, special mobile force, and the national coast guard were all employed to check the adherence to the rules and regulations by the population of Mauritius. [14]

On March 26, 2020, a mobile application, beSafeMoris was launched by the Ministry of Technology, Communication and Innovation. The application comprised the following information: news and communiqués, health tip videos, maps and directory of health centers, quick access to hotline numbers, push notifications on news and vital information and addressed the frequently asked questions regarding public health. [15] On March 28, 2020, the ENT hospital in Vacoas received patients who tested positive, and as a result, the ENT patients were redirected to Victoria Hospital, Candos. In the following communiqués released by the Government of Mauritius and the live conference with the Prime minister extended the lockdown up to April 15, 2020. The people of Mauritius were advised to follow strict social distancing measures and sanitary protocols; marks were made at a distance of one meter at the supermarkets, wearing masks was compulsory, before entering the supermarket a temperature check and sanitizer application was to be done, people were allocated days on the basis of their surnames. These rules were strictly followed by the supermarkets. Furthermore, the value-added tax (VAT) on masks and hand sanitizer were removed. [16] Quarantine centers were set up at various hotels and resorts to keep the virus contained. Online classes were introduced in schools and colleges to continue their education safely at home.

Mauritius also received large shipments of medicine, including 500,000 Hydroxychloroquinine tablets, to treat COVID-19 positive patients on April 16, 2020. [17] The government also emphasized providing adequate Personal Protective Equipment (PPE) for the personals at risk. [13] On May 31, 2020, the Ministry of Health and Welfare continued to screen people. All the public and private sector frontline traders were allowed to start operations from June 01, 2020. However, they followed strict measures like sanitation of premises, masks, hand sanitizers, and daily temperature recording. [18] Passengers from flights were quarantined and tested to prevent the entry of foreign cases amongst the country's population. [19]. As of June 02, 2020, there was no new case reported via community transmission. [1]

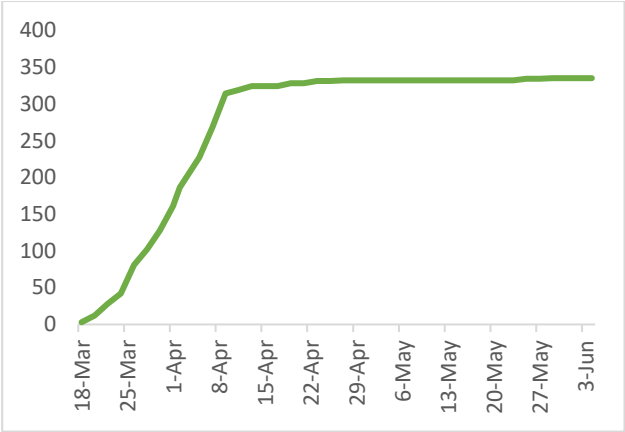

Figure 1: Shows the flattening of curve in Mauritius in 2020

Figure 1 determines the flattening of the curve. The X- axis represents the months of year 2020 and the Y-axis determines the total number of COVID-19 positive cases detected in Mauritius

Table 1: Demographic details of number of deaths due to COVID-19 in Mauritius [20]

Death number	Age	Gender
1	52	Male
2	59	Male
3	76	Male
4	69	Male
5	71	Male
6	20	Female
7	59	Male
8	Unidentified/Unknown	Male
9	63	Male
10	63	Male

Table 1 represents the demographic details viz. age and sex of the number of deaths due to COVID-19 in Mauritius. Out of 10 deaths, most of the patients were male 90% and the rest were females 10%.

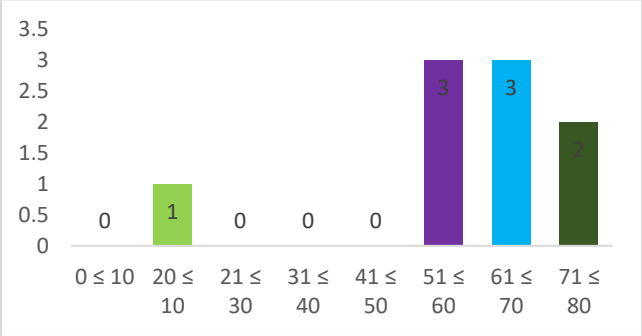

Figure 2: Age distribution of COVID-19 Deaths in Mauritius

Figure 2 signifies the various age groups and deaths in various age groups: no death was recorded on age groups 0≤ 10 years, while 11 - ≤ 20 years recorded 1 death. Furthermore, age groups 51 - ≤ 60 and 61 - ≤ 70 years both recorded 3 deaths each and age 71 - ≤ 80 years recorded 2 deaths.

Current drug therapy being used in Mauritius

Hydroxychloroquine: This drug has been successfully used in Mauritius on COVID-19 patients. The spokesperson of the National communication committee on COVID-19 made this announcement "This drug has been extensively used as a treatment against the novel coronavirus, and Mauritius itself has so far successfully treated 322 patients over 334 with it." [20]

Plasma therapy

The plasma from recovered patients was extracted and given to patients in critically ill patients by IV plasma infusion to improve patients' immune system. [21, 22] Almost all of the patients who were started on the plasma therapy showed improvements, including adsorption of lung lesions and removal from the ventilator. [23] It was reported that individuals' well-tolerated plasma therapy and no severe side effect led to increased mortality. [24]

Table 2: Oxford COVID -19 response tracker of various countries

Country	10 days after	20 days after	30 days after
Mauritius	82.41	82.41	82.41
Fiji	84.26	88.9	88.9
New Zealand	19.44	36.11	93.1
Spain	11.11	11.11	11.11
India	10.19	10.19	10.19

Table 2 denotes the factors comparison was drawn with Fiji [25] and New Zealand [26], similar to Mauritius in having controlled the outbreak. According to the data Mauritius, Fiji, and New Zealand showed more stringent action in the initial days of the lockdown and successfully control the outbreak. In contrast, India and Spain failed to do so. Mauritius, India and Spain had 82.41%, 10.19%, 11.11% respectively after 10, 20 and 30 days, whereas Fiji showed variation – 84.26% after ten days of the first case and 88.9% 20 days and 30 days. New Zealand also showed variations from 19.44% after ten days from the first case to 36.11% after 20 days of the first case to 93.1% after 30 days from the first case. [27]

Discussion

COVID-19 is a deadly virus not because of its mortality rate but because of its high transmission rates. There are four transmission stages: sporadic cases, local transmission, clustered community transmission, and widespread community transmission. Viral transmission is also influenced by a country's socioeconomic factors, including its population density and behavior of the population. In addition, the susceptibility of a population also signifies the rate of transmission of the virus. Therefore, the aim to control a pandemic/epidemic is to restrict the spread and prevention of widespread community transmission. [28] In this study, we discovered that barriers created in the transmission of the virus led Mauritius to become the second African country to control the outbreak. Various interrelating factors also led to the effective control of the outbreak. The essential factor that helps to flatten the curve was the complete lockdown in the first ten days. This was possible because of the application of strict laws and regulations regarding COVID-19. The health sector's efficiency in terms of treatment of the positive cases and the funds directed towards all aspects of COVID-19 supplemented the results. Even though a direct relationship cannot be presented, this study, when compared to other countries. The countries considered were Fiji and New Zealand, which effectively managed to control the outbreak and in contrast to India and Spain, which were still fighting to control the deadly virus.

Fiji is an Oceanic country with an area of 18,270 km^2 and a population density of 49/km^2, [29] the case zero was detected on the March 19, 2020. [30] According to their timeline, Fiji imposed quarantine measures for passengers and inter-island shipping movements by March 27 and 28, 2020 respectively. A curfew was ordered on March 30 at five active cases. The Fijian government advised a 28-day self-quarantine. On April 26, the government started relaxing its curfew. [30] The Fijian government also announced an economic bail of up to 1 billion Fijian dollars. [31] At the time of this study, up to 4000 tests were conducted by the government. Fiji had a total of 26 cases. Fiji was declared a COVID-19 free county on June 05, 2020. [25]

New Zealand is an island with a land area of 263,310 km^2. It has a population density of 18/km^2. [32] New Zealand confirmed its case zero on February 28, 2020. [33] On March 25, when there were 283 cases, New Zealand announced Alert Level 4 with the closure of schools and non-essential businesses. The government also banned gatherings and domestic flights. Additionally, the country closed its international borders, only allowing repatriation flights for its citizens who were asked to self-quarantine. New Zealand also placed strict sanitation measures, including social distancing and the wearing of masks. From April 10th, 2020, the incoming passengers were placed under supervised quarantine. At the time of this study, 429,643 cases were tested. The number of cases totaled 1194 as of June 08, 2020 [26] when New Zealand was declared COVID free, and no new cases have been detected since. India, a South Asian country, contains the 2nd highest population globally at 1,380,004,385 people, and a population density of 460/km^2 is another country with an increased number of COVID-19 cases. [34] India confirmed its first case on January 30, 2020. These cases had directly come from China. A Janta Curfew was enforced on March 22, 2020 and was extended from 7 AM to 9 PM. [35] After that, 5 Phases of lockdown were introduced (Phase I-V). Phase I started on 24th March 2020,

and the provisional date was until the April 14, 2020. It was further extended until the May 3, 2020 (Phase II), then an extension for 14 days until the May 17, 2020 (Phase III), and Phase IV extended until the May 31, 2020. India also restricted travel entry; by 13th March 2020, all visas were suspended except diplomatic and official visas. [36] Regarding funds for COVID-19 on the 24th of March 2020, a sum of Indian Rupees 150 billion was directed to the health care sector. [37] In addition to that, a package of 20 trillion Indian Rupees was directed towards the Atma Nirbhar Bharat which constituted 10% of the GDP. [38] India, as of the time of this study had 936,628 cases of COVID-19. A total of 12,092,503 tests had been conducted. [39]

Spain has an area of 506,000 km^2 and a population density of 94/km^2. [40] Zero cases in Spain was detected on January 31, 2020. [41] The total cases sharply increased to 303,699 as of the July 14, 2020. The lockdown was enforced on the 14th March 2020 and continued till 21st June. By the May 15, quarantine centres were opened. [42] On the 20th of March 2020, the borders were also closed for travel. Two different parameters have been used in this data: GHS Score and Oxford COVID-19 Response Tracker that combine various factors solidified into scores for an easier comparison of the data.

Global Health Security Index (GHS Index)

The GHS Index determines the countries' capacity to deal with a pandemic threat. This includes the countries' response to a disease. It is an assessment of health capacities. The GHS data is acquired from publicly available data and data available from published health organizations like WHO and academic resources and publications. The GHS Index score is calculated to the highest score of 100. The average GHS score among the 195 countries is 40.2. Furthermore, countries with a high income tend to have a higher score in general. The overall index score for Mauritius is 34.9 and ranks 114 of the 195 countries. And ranks 17 of the 54 countries in Africa. Fiji has a GHS index of 25.7 and ranks 168/195, which is a low score compared to Mauritius, despite which it has managed to control the pandemic. The problem here could lie in the lack of detection of cases. India has a score of 46.5 and ranks 57 out of 195. This shows that India has a good capacity to deal with any health threat. In comparison, Spain has an outstanding score of 65.9 and ranks 15 out of 195 countries. It shows an excellent capacity to deal with an outbreak. New Zealand has a score of 54.0 and ranks 35/195.

There are evident discrepancies in the GHS scores and the end result of controlling the outbreak. This is because the GHS index also estimates the financial impact during an outbreak in a country. Countries with a higher income would have a higher score. This intern means that they would be less handicapped financially after a health threat than other countries with a lower GHS score. [43]

Oxford COVID-19 government response tracker

This is an ongoing research paper taking into account 17 indices to measure the stringency of the actions were taken by the governments of different countries to control the outbreak specific to COVID-19. These 17 indices have been aggregated into four common indices and report a number between 1 and 100. These are the overall government response index, containment, health index, economic support index and the original stringency index.

In this study, we compare these indices on the 10th, 20th and 30th day from the detection of the first case in the country. [27] According to this data, there is a direct relationship between the strictness of the government and a successful outcome. Delay in lockdowns has adversely affected the results because of an early start of community transmission.

Regardless of the country's ability to handle a potential threat, its measures during the outbreak play a more valuable role in determining how efficiently the outbreak is controlled.

Conclusion

This study shows the broad aspect of COVID-19 from the perspective of Mauritius. The vital factor was an early lockdown. The degree and strictness of the lockdown are directly proportional to the effective control of COVID-19. Measures have to be taken to ease the strain in the general public's personal and financial life, ensuring public compliance to the rules and regulations made by the government. In addition, mass awareness programs are also necessary to educate the public on the threat of COVID-19 and how they can aid the country in fighting the outbreak. Furthermore, in comparison with different countries, this hypothesis proves to hold true. Countries like New Zealand and Fiji ensured a strict lockdown in the early days, leading to them being free of the outbreak.

An effective health care system in the country and quantitative funds indicate how the burden of the outbreak would be handled by the country rather than their efficiency to control it. Whereas the measures are taken by the government, its implementation and the adherence of the population to these measures play a significant role in controlling the outbreak. It is to be noted that the more intricate measures have yet to be studied.

Recommendations

The results provided by this study indicate the importance of stringent rules and regulations in a mass pandemic. Early implementation of these laws and regulations prevents and stops the community transmission of the virus. In these devastating circumstances, the countries that haven't managed to control the outbreak can heed this small island nation. Strict laws and regulations with heavy penalties and concern the well-being of its population, particularly the low-

income groups, can help the governments of various countries control the outbreak.

Abbreviations

Coronavirus disease (COVID-19), distribution factor (df), gathering factor (gf), Global health security index (GHS), Mauritian rupees (MUR), Middle East respiratory syndrome corona virus (MERS-CoV), personal protective equipment (PPE) risk of exposure (ROE), sanitation and hygiene practices (shf), Seewoosagur Ramgoolam Medical College (SSR Medical College), Seewoosagur Ramgoolam Medical College (SSRMC), Severe acute respiratory syndrome corona virus (SARS-CoV), Severe acute respiratory syndrome corona virus -2 (SARS-CoV-2), Value-added tax (VAT), Weather factor (wf)

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Authors' contribution

a. Study planning: IB, MA
b. Review of literature: MA, RA, SA, RP, IB
c. Manuscript writing: MA, RA, SA, RP, IB
d. Manuscript revision: MA, RA, SA, RP IB
e. Final approval: MA, RA, SA, RP IB
f. Agreement to be accountable for all aspects of the work: MA, RA, SA, RP IB

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