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Impacts of Non-Pharmaceutical Interventions (NPIs) on the Trends of COVID 19 Pandemic in selected MENA Region Countries

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Abstract: This study covers eleven Middle Eastern and North African (MENA) countries and aimed to analyze the impact of public health and societal measures (hereunder called non-pharmaceutical interventions - NPIs) taken to suppress and/or mitigate the pandemic within these countries at the early stages of its spread. In the absence of a vaccine, we assessed the actual role of these NPIs in reducing transmission of the virus and managing the crisis. NPIs investigated are flight suspensions, restrictions on gatherings, school closures as well as intermittent lockdown. The impact of NPIs on the outbreak dynamics was assessed by the number of cases per million people and the number of deaths per thousand people. Results indicate that dynamics of the outbreak differ from one country to another as NPIs differ in kind, timing, swiftness and adaptation of the public to enforced measures. Although testing is extremely important in detecting infection and reducing the mortality ratio (in terms of deaths per 1000 reported cases) by 45%, the analysis in this study shows that NPIs play a very important role in containing the pandemic and reducing its impact. Slower responses in terms of NPIs implementation resulted in up to 67 % increase in mortality rate (deaths per 1000 reported cases). The outcome of this study can help in dealing similar events in the future.

Keywords: COVID-19, Non-Pharmaceutical Interventions (NPIs), Pandemic Dynamics, MENA Countries.

1. Introduction

During the first few months of 2020, people around the world started to follow the disturbing news coming from China regarding a new human respiratory illness, identified as a novel coronavirus or COVD-19. The illness was first identified in Wuhan City, Hubei Province of China and reported to the WHO China Country Office on 31 December 2019 [1].

The illness rapidly spread to countries around the world. By March 11th, 2020, more than 118,000 cases of COVID-19 were reported in 114 countries which lead to the characterization of COVID-19 as a pandemic by the World Health Organization (WHO) [2]. By the end of April 2020, the total cases had surpassed five million with a death total exceeding 326,000 worldwide [3]. Research suggested a remarkable genomic resemblance of 2019-nCoV to Severe Acute Respiratory Syndrome (SARS) which has a history of a pandemic in 2002 [4,5].

The Public Health Emergency of International Concern (PHEIC) has been established by the World Health Organization (WHO) with strategic objectives for public health to curtail the outbreak's impact on global health and economy.

COVID-19 is identified as highly infectious and can be transmitted through droplets and close contact. The relatively long 14-day incubation period is a serious challenge [6,7]. Controlling the spread of the epidemic and reducing mortality as soon as possible is vitally important. Researchers have been assessing the reported data from infected countries to get a better understanding of the

spread dynamics of this outbreak. The specific mechanism of the virus at early stages of the spread was unknown to a certain extent, and no specific antiviral drugs have been developed [3, 4, 6, 8]. Therefore, it is important to control the source of infection, cut off the route of transmission, and use existing drugs and means to control progress of the disease proactively [5, 9].

Social distancing is an essential measure in counteracting the pandemic and stretching the curve. Strict implementation and timing of preventive and precautionary measures that support such behavior is far more important than announcing them and should be properly contextualized, meaning that social and collective consciousness is indispensable [10, 11]. Hence, it is crucial to monitor the progress of this outbreak and evaluate the effects of preventive and precautionary measures, including the social distancing measures in real-time.

As the COVID-19 pandemic progressed , countries implemented a broad range of responses and measures to slow the spread of the virus, from quarantines to school closures, and more than a third of the planet's population was under some form of restriction [10, 11].

Ferguson et al. (2020) identified two strategies to deal with the pandemic in European countries and the United States, namely: mitigation and suppression. They found that optimal mitigation policies might reduce peak healthcare demand by two-thirds and deaths by half. Suppression, which aims to reverse epidemic growth, reducing case numbers to low levels and maintaining that situation continuously, is more appropriate to countries with fewer resources and less adaptive health systems but requires the layering of more intensive and socially and culturally disruptive measures than mitigation [12].

To avoid a rebound in transmission, these policies need to be maintained until large stocks of vaccine are available to immunize the population – which could be 18 months or more [12, 13]. If intensive NPI packages aimed at suppression are not maintained, their analysis suggests that transmission will rapidly rebound, potentially producing an epidemic comparable in scale to what would have been seen had no interventions been adopted [14 – 16]. Chinazzi et al (2020) suggests that travel restrictions have modest effect on reducing the spreading of COVID-19. They also argue that the main cause for relieving the epidemic is by transmission reduction interventions [17].

Lou et al (2020) analyzed the available data by the Center for Systems Science and Engineering at Johns Hopkins University in the period between February 22nd, 2020 and March.15th,2020 [18]. They concluded that there is a need to analyze data from many countries to proof any hypothesis regarding this pandemic as culture factors may have a large impact on infection rate. Moreover, Ghiasvand shows the results of the curfew that started in Germany as of March 22nd, 2020 which had a crucial impact on slowing down the spread of COVID-19 [19].

The valid measures to slowed down the spread of the pandemic and flattened the curve of cases are non-pharmaceutical such as case isolation, travel restrictions, curfews and social distancing [18 - 24]. According to the Chinese government, lockdown in some areas caused the pandemic to show an increase in the doubling time of COVID-19 cases in these areas while the number of cases increased outside these areas [25]. Therefore, lockdown helped the healthcare sector to buy time by reducing daily number of cases but its effectiveness depends on different social contexts [26]. Generally speaking, the effectiveness of any intervention alone is likely to be limited, and therefore, a set of multiple interventions should be deployed to have an effective impact on transmission and containment of the outbreak.

Most countries in the MENA region had implemented unprecedented non-pharmaceutical interventions (NPIs) including case isolation, schools and universities closures, banning of mass gatherings and/or public events, and wide-scale social distancing including local and national lockdowns.

This paper documents the list of NPIs implemented by selected MENA countries, and investigates the impacts of such measures on the dynamics of COVID19 pandemic in these countries at early stages of the outbreak. The interventions considered (The Parameters) are the number of tests per million people, the date of flight suspension, the date of gathering restrictions and the date of partial or national lockdown. The impacts of these parameters on the dynamics of the pandemic outbreak are documented in terms of the following responses: number of cases per million people, the number of deaths per thousand people and the number of deaths per thousand tests implemented.

Other factors at country level are also important such as level of preparedness, vulnerability, governance status, flexibility and responsiveness of the national governmental health sectors as well as the economic and social characteristics in each country. The study focuses on analyzing the pandemic progression in each of the investigated MENA countries and relates the spread pattern to preventive and precautionary measures (NPIs) implemented by each country.

2. Methods and Procedures

Data from the date first confirmed cases to April 25, 2020, for 11 MENA countries were imported from the Worldometers website [27]. Data collected include: population in million, total number of confirmed COVID-19 cases, total number of tests, number of test per million of population, number of cases per million of population, total number of deaths, number of deaths per million of population, and date of first confirmed case of COVID-19.

The number of reported deaths per million, number of reported deaths per thousand tests and the number of deaths per thousand cases were calculated. Figure 1 shows the progress of pandemic in each of the investigated MENA country. Table 1, 2 and 3 give a summary of collected data on three occasions: April 10, 2020, April 21, 2020 and April 25, 2020

Data on implementation and timing of preventive and precautionary measures in response to COVID-19 pandemic in the investigated countries that support social distancing behavior was also collected. Table 4 gives a summary of collected data on these preventive and precautionary measures (NPI: Non Pharmaceutical Interventions) as well as the date of the first confirmed cases in each of the investigated country.

The first case in the selected countries was identified and reported on February 15th, 2020, in UAE, Egypt and Algeria, followed by the detection of cases in other countries later. However, the number of confirmed cases of COVID-19 started to increase in the subsequent days.

To organize our analysis into useful insights that can be of benefit for other countries in the region and in the southern hemisphere, we organize the NPIs and measures taken collectively called as parameters versus the output indicators or impacts of such measures on the progression of the pandemic, namely the number of deaths per million, the number of deaths per reported positive cases of infection (Table 5).

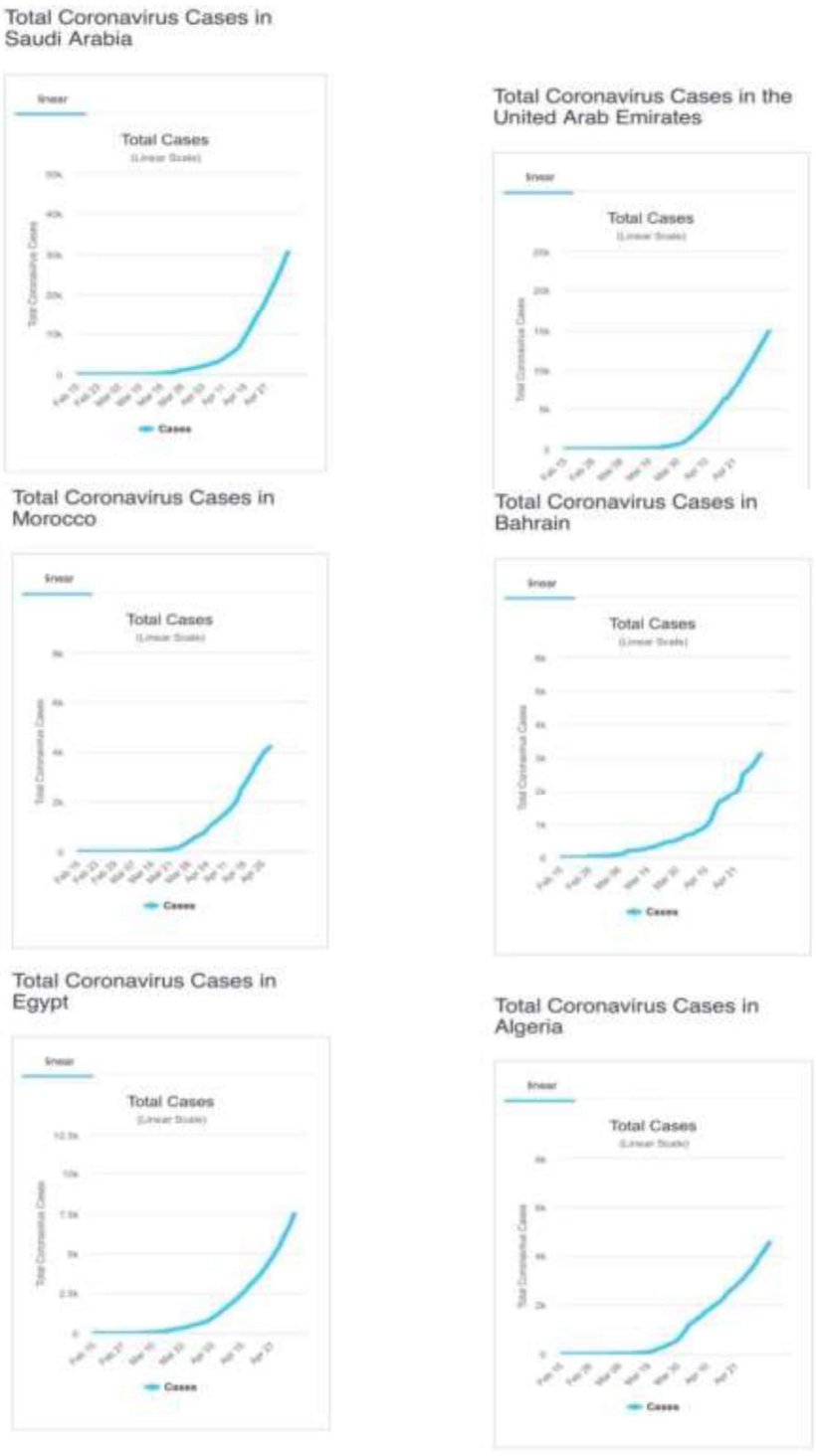

Figure 1: Progression of COVID 19 cases in selected MENA countries

Figure 2: Progression of COVID 19 cases in selected MENA countries (Cont'd)

Table 1: Pandemic variables for selected MENA countries as of April 10, 2020

As of Apr 10 2020									
Country	Population in M	Total Number of Confirmed Cases	Total Number of Tests	Number of Test per M	Number of Cases per M	Total Number of Deaths	Number of Deaths per M	Number of Deaths per Thousand Tests	Number of Deaths per Thousand Cases
Qatar	2.881	2,512	45339	15737	872	6	2.08	0.132	2.389
UAE	9.890	3360	593095	59967	340	16	1.62	0.027	4.762
Bahrain	1.702	998	57681	33899	587	6	3.53	0.104	6.012
KSA	34.814	3,651	115585	3320	105	47	1.35	0.407	12.873
Jordan	10.203	372	17000	1666	36	7	0.69	0.412	18.817
Lebanon	6.285	619	13530	1982	91	20	3.18	1.478	32.310
Tunisia	11.819	671	10087	853	57	25	2.12	2.478	37.258
Iraq	40.222	1279	32158	800	32	70	1.74	2.177	54.730
Morocco	36.911	1448	7239	196	39	107	2.90	14.781	73.895
Egypt	102.334	1,794	25000	244	18	135	1.32	5.400	75.251
Algeria	43.851	1761	3359	77	40	256	5.84	76.213	145.372

Table 2: Pandemic variables for selected MENA countries as of April 21, 2020

As of Apr 21 2020									
Country	Population in M	Total Number of Confirmed Cases	Number of Tests	Number of Tests per M	Number of Cases per M	Number of Deaths	Number of Deaths per M	Number of Deaths per Thousand Tests	Number of Deaths per Thousand Cases
Qatar	2.881	6,533	66725	23160	2268	9	3.12	0.135	1.378
UAE	9.890	7755	790000	79875	784	46	4.65	0.058	5.932
Bahrain	1.702	1973	94380	55466	1160	7	4.11	0.074	3.548
KSA	34.814	11,631	180000*	5170	334	109	3.13	0.606	9.372
Jordan	10.203	428	33000	3234	42	7	0.69	0.212	16.355
Lebanon	6.285	677	21764	3189	99	21	3.34	0.965	31.019
Tunisia	11.819	901	18165	1537	76	38	3.22	2.092	42.175
Iraq	40.222	1602	60837	1513	40	83	2.06	1.364	51.810
Morocco	36.911	3209	18100	490	87	145	3.93	8.011	45.185
Egypt	102.334	3,490	55000	537	34	264	2.58	4.800	75.645
Algeria	43.851	2811	6500	148	64	392	8.94	60.308	139.452

* The total number of tests in Saudi Arabia as of April 22nd, 2020

Table 3: Pandemic variables for selected MENA countries as of April 25, 2020

As of Apr 25 2020									
Country	Population in M	Total Number of Confirmed Cases	Number of Tests	Number of Tests per M	Number of Cases per M	Number of Deaths	Number of Deaths per M	Number of Deaths per Thousand Tests	Number of Deaths per Thousand Cases
Qatar	2.881	9,358	79705	27665	3248	10	3.47	0.125	1.069
UAE	9.890	9813	1E+06	103365	992	71	7.18	0.069	7.235
Bahrain	1.702	2588	110379	64869	1521	8	4.70	0.072	3.091
KSA	34.814	16,299	200000	5745	468	136	3.91	0.680	8.344
Jordan	10.203	444	63737	6247	44	7	0.69	0.110	15.766
Lebanon	6.285	704	26467	3878	103	24	3.82	0.907	34.091
Tunisia	11.819	939	20408	1727	79	38	3.22	1.862	40.469
Iraq	40.222	1763	68224	1696	44	86	2.14	1.261	48.780
Morocco	36.911	3897	25443	689	106	159	4.31	6.249	40.801
Egypt	102.334	4,319	90000	879	42	307	3.00	3.411	71.081
Algeria	43.851	3256	6500	148	74	419	9.56	64.462	128.686

Table 4: Non-Pharmaceutical Interventions (NPIs) taken and date of action in selected MENA countries

Country	Date of first confirmed case (s)	Date of flight suspension	Days to flight suspension	Business / Public Gathering Restrictions	Days to Business / Public Gathering Restrictions	Date of first Nationwide partial curfew	Days to first Nationwide partial curfew	Number of cases on the partial Curfew day
Qatar	Feb 29 2020	Mar 17th, 2020	17	Mar 16th, 2020	16	N/A	N/A	N/A
UAE	Feb 15 2020	Mar 24th, 2020	38	Mar 25th, 2020	39	March 26th, 2020	40	333
Bahrain	Feb 24 2020	N/A	N/A	March 19th, 2020	24	March 24th, 2020	29	392
KSA	March 2 2020	Mar 15th, 2020	13	March 25th, 2020	23	March 23rd, 2020	21	562
Jordan	March 2 2020	Mar 17th, 2020	15	March 17th, 2020	15	Mar 21st, 2020	19	100
Lebanon	Feb 21 2020	Mar 18,2020	26	Mar 18,2020	26	March 26th, 2020	34	368
Tunisia	March 2 2020	Mar 17th, 2020	15	March 17th, 2020	15	March 17th, 2020	15	27
Iraq	Feb 21 2020	Mar 17th, 2020	25	March 9th, 2020	17	March 22nd, 2020	20	233
Morocco	March 2 2020	Mar 15th, 2020	13	March 16th, 2020	14	March 19th, 2020	17	63
Egypt	Feb 15 2020	Mar 19th, 2020	33	March 22nd, 2020	36	March 25th, 2020	39	456
Algeria	Feb 25 2020	Mar 17th, 2020	21	March 10th, 2020	14	N/A	N/a	N/a

Table 5: Listing of NPI parameters taken and response/indicator of outbreak mitigation potential

#	**Response indicator**	**Acronym**	**NPIs Parameter**	**Acronym**
1	Total number of cases	TNCs	Total number of tests	TNTs
2	Cases per million	CPM	Tests per million	TPM
3	Total number of deaths	TND	Days to flight suspension since the first reported case	DFS
4	Deaths per million	DPM	Days to business / public gathering restriction since the first reported case	DBP
5	Deaths per thousand tests	DPKT	Days to nationwide curfew since the first reported case	DNC
6	Deaths per thousand cases	DPKC		

3. Results and Discussion

Amid collecting and processing numerical data of the casualties, specialists in diverse fields are probing and looking beyond the numbers. First and foremost, the publicized numbers are indices of the health system's efficiency in detecting, locating and suppressing the spread of the disease. In this regard, detecting the infections is essential to containing the spread and determining its pattern. The low confirmed cases are popularly welcome, but professionally a cause for unease. The reported positive cases are cases a country managed to detect simple and pure. The devil is in the undetected cases wandering and spreading the virus. Figure 2 presents number of tests per million of population versus number of reported cases per thousand in the selected MENA countries as of April 25, 2020.

Figure 2 suggests that the four GCC gulf countries, namely: KSA, UAE, Qatar and Bahrain have significantly higher counts of cases per million people than the rest of countries in this study. Kuwait and Oman were the two GCC gulf countries that were not considered in this study due to the unavailability of data on number of test performed by each county. This coincides with the fact that these Gulf countries conducted higher number of tests per million people. Figure 3 presents number of tests per million versus the reported number of deaths per 100 thousand cases for the investigated countries as of April 25th, 2020. Algeria, Morocco and Egypt are high in Deaths per million while the three countries were lowest in tests per million and also lowest in cases per million. This might indicate they had many undetected and consequently unreported cases. Figure 4 & 5 displays the relation between mortality rates in terms of (deaths per thousand reported cases) compared to time delay in enacting suspension of flights and curfew.

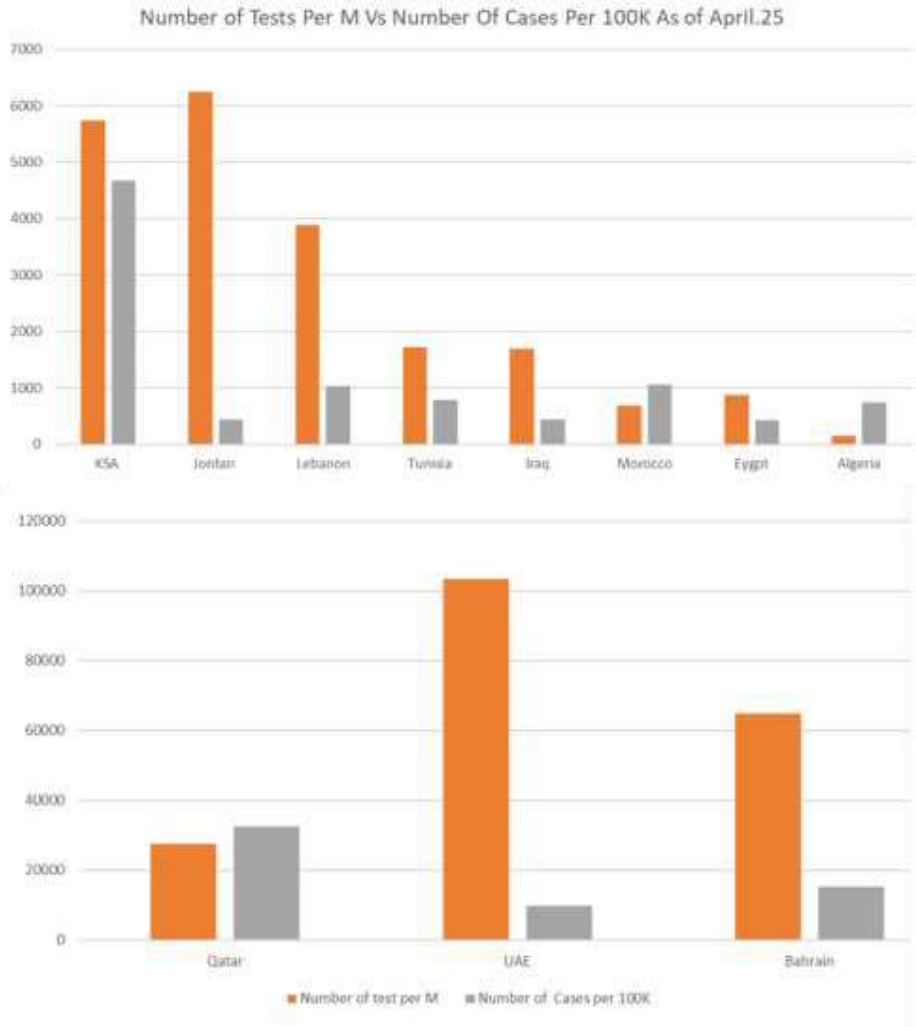

Figure 2: Number of tests per million versus number of reported cases per thousand in 11 MENA countries as of April 25, 2020

For the case of Iraq and Tunisia, figure 6, the two countries performed a comparable number of tests per million of population as of April 25th, 2020. But Iraq was slower in restricting mobility, internally and externally. It took Iraq 5, 2, and 10 more days (since first reported case) to their first nationwide curfew, Business / Public Gathering Restrictions, and flight suspension respectively, resulting in 23% increase in deaths per 1000 reported cases in Iraq as of Apr. 25th, 2020.

Same trend was noticed for the case of Egypt and Morocco, figure 7. The two countries performed a comparable number of tests per million of population as of April 25th, 2020, but Egypt was slower in restricting mobility, internally and externally. It took Egypt almost double the time to their first nationwide curfew (38 vs. 17 days since first reported case) and more than double the time to their first Business / Public Gathering Restrictions (36 vs. 14 days since first reported case). Egypt was also slower in their flight suspension. It took Egypt nearly triple the time (33 vs. 13 days since the first reported case). Consequently, 67.4 % increase in deaths per 1000 reported cases as of April 25th, 2020 was noticed in Egypt compared to Morocco.

Tunisia and Morocco, figure 8, reported their first cases at the same date. They responded similarly in terms of a nationwide curfew, Business / Public Gathering Restrictions, and flight

suspension. But Tunisia was more active in conducting tests per million of population. As of April 10th, 2020, Tunisia has conducted more than four times more tests per million of population (853 vs. 196 test per million) as of April 10th, 2020 when compared to Morocco. Tunisia reported 46 % more cases per million of population, but the mortality ratio in Morocco was almost double. Morocco reported 98.3 % increase in deaths per 1000 reported cases than Tunisia as of April 10th, 2020. Later, Morocco intensified their testing programs, and reduced the gap with Tunisia (1727 vs. 689 tests per million of population) as of April 25th, 2020. As a result, Morocco was able to reduce the mortality ratio in terms of deaths per 1000 reported cases by 45%, from 73.9 to 40.8 cases of deaths per 1000 reported cases of infection.

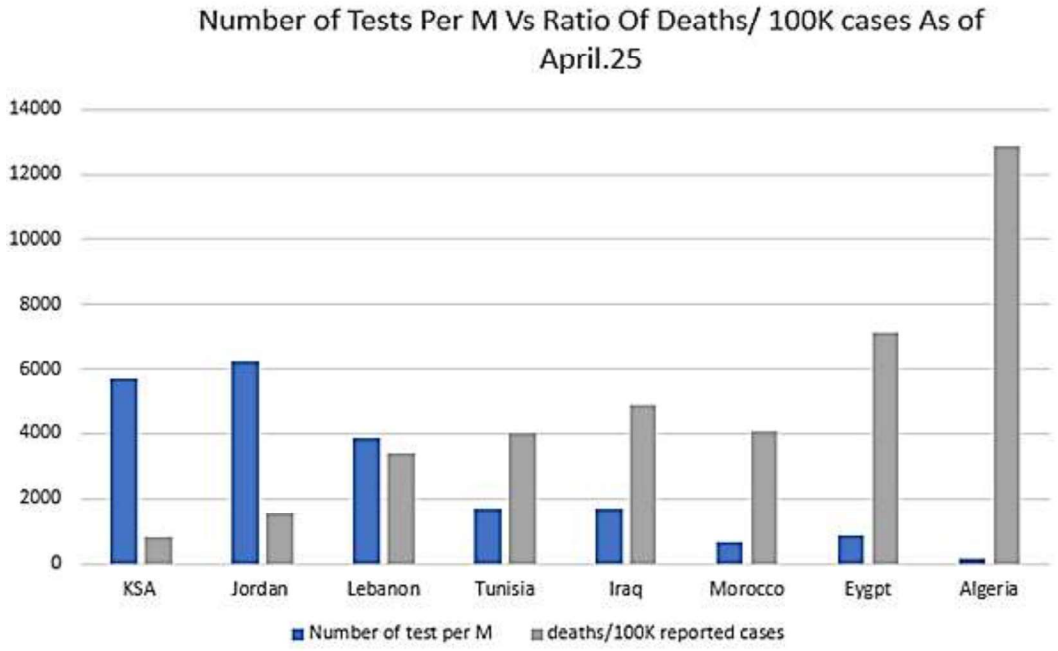

Figure 3: Number of tests per million versus the reported number of deaths per 100 thousand cases for the investigated countries

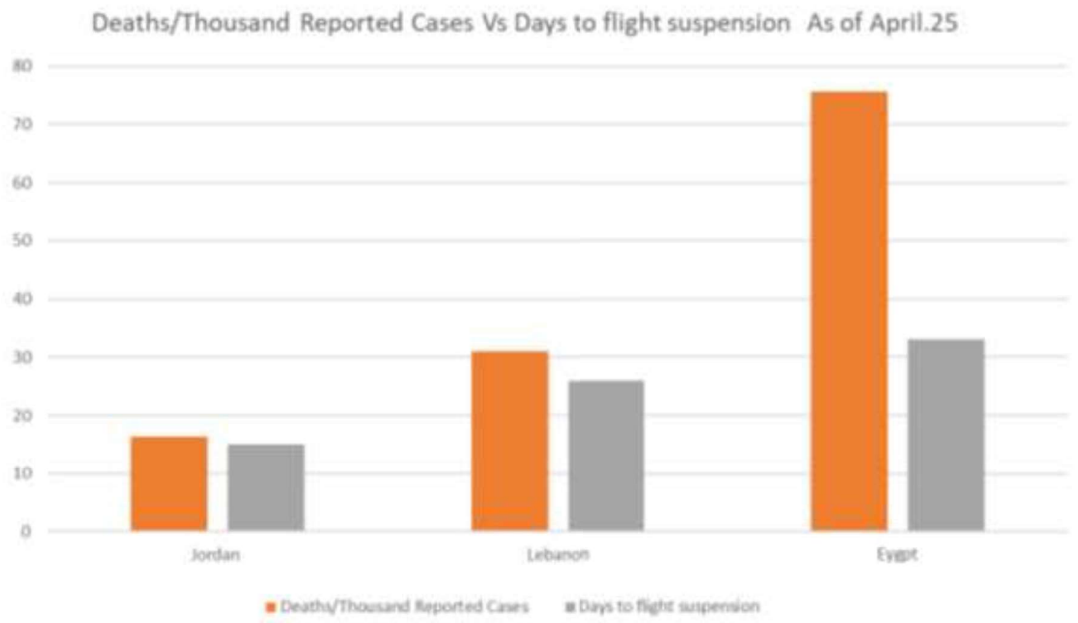

Figure 4: Deaths per thousand reported cases compared to time delay in enacting suspension of flights

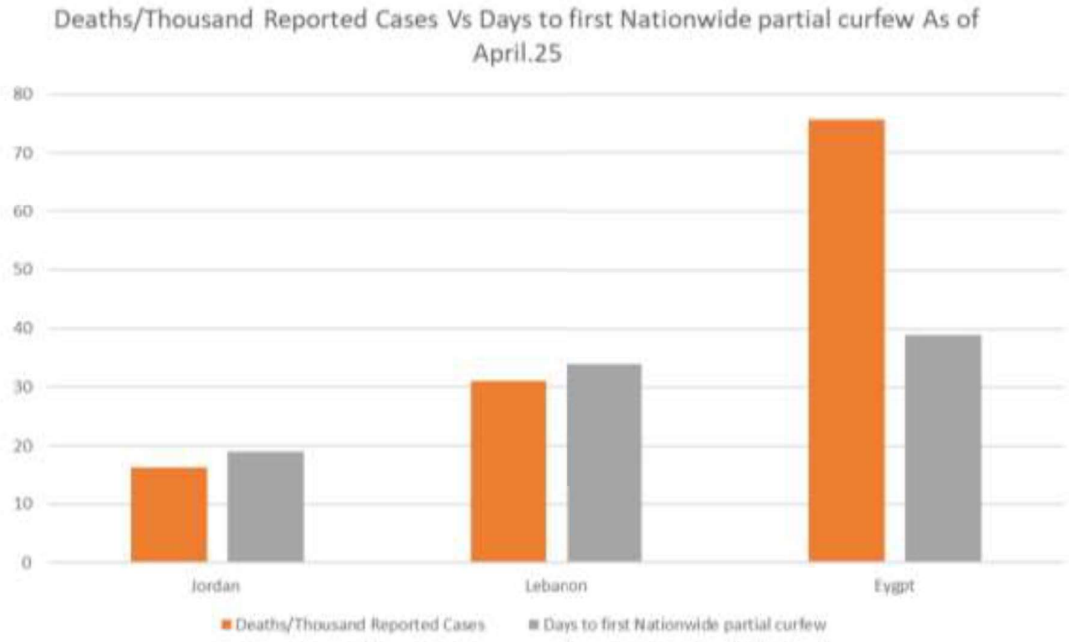

Figure 5: Deaths per thousand people compared to time delay in enacting curfew

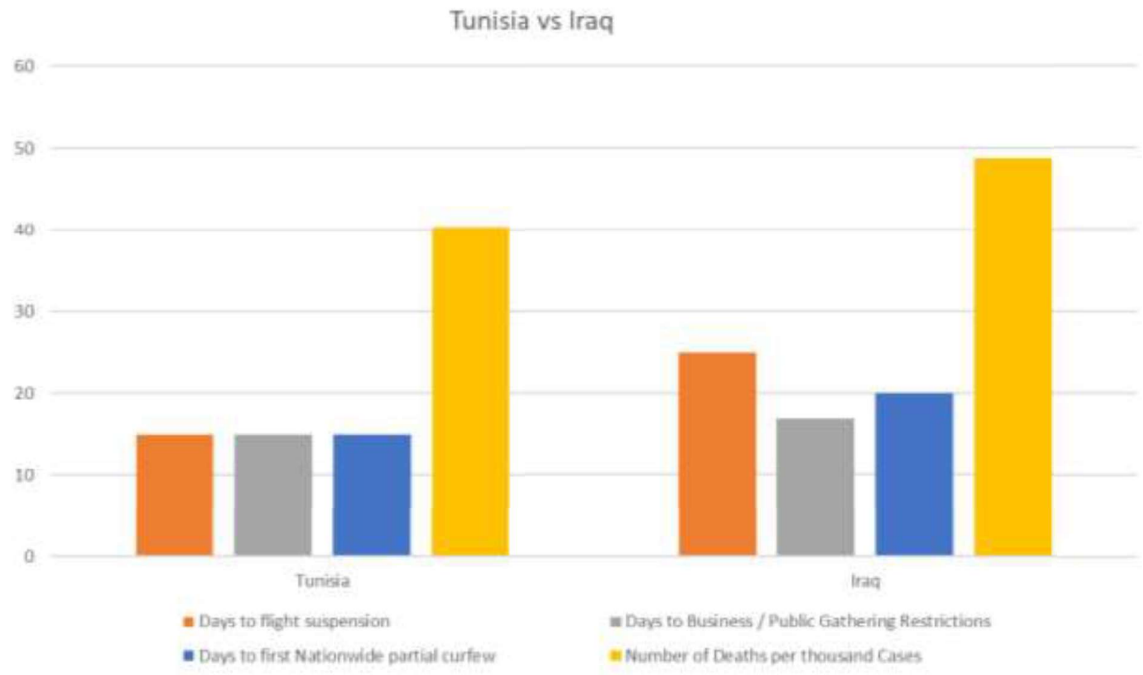

Figure 6: Deaths per thousand reported cases in Tunisia and Iraq as influenced by NPIs as of April 25 th, 2020.

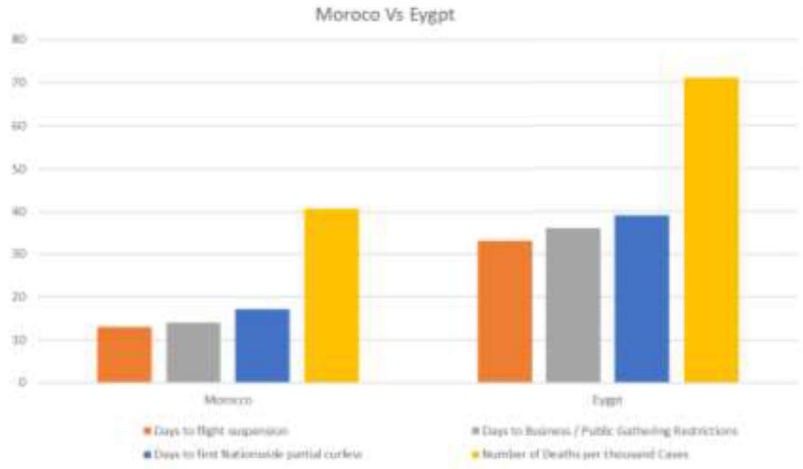

Figure 7: Deaths per thousand reported cases in Egypt and Morocco as influenced by NPIs as of April 25th 2020.

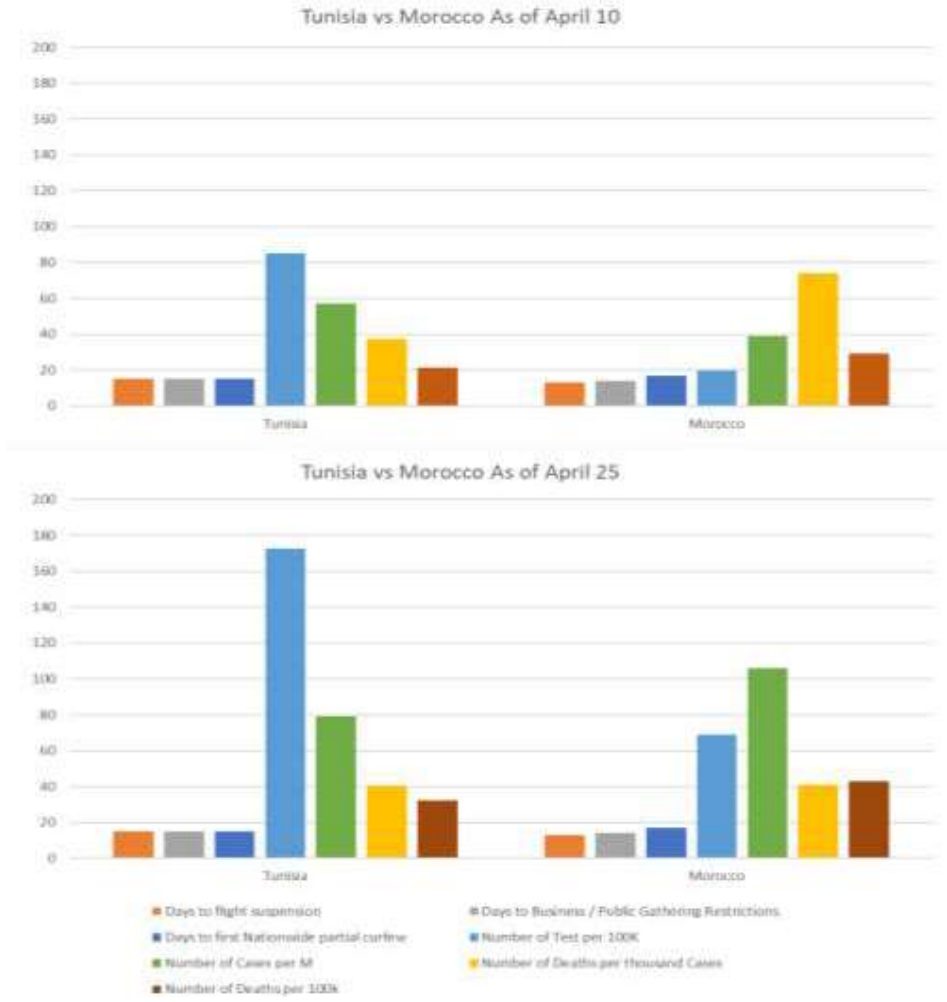

Figure 8: Impact of NPIs taken on dynamics of the outbreak (deaths per 100K and deaths per thousand cases between April 10th and April 25th, 2020 in Tunisia and Morocco

The contradictory statistics in some cases are indicators of desperation and exhaustion permeating the healthcare system that could no longer contain the pandemic. The decreasing confirmed cases are alarming and can translate the low numbers into overstrained medical teams that are incapable of reaching out or detecting all existing cases. This concern stood on another foot yet: the surge in reported deaths. The latter could either be due to late detection or triaging dictated by the influx of new patients.

On the one hand, constant high numbers could be an assuring sign: it is the apex; it may signal that these countries' detection aids have been pushed to their limits. Perhaps, the detection efforts target one hot spot at the cost of less urgent ones.

The Jordanian case represents a rather different model. The speedy reaction and resolute implementation of one of the strictest measures preemptively contributed to containing and slowing down the spread. The country succeeded in slowing the spread at early stages of the pandemic.

The social and economic costs of NPIs on societies of the selected MENA counties have been high and some governments are struggling to keep a balance between suppressing the outbreak and maintaining acceptable levels of economic activities. The results of this study are useful to other countries in the southern hemisphere of similar governance, cultural and political conditions to MENA countries.

4. Conclusions and Recommendations

Based on the analysis in this study, the NPIs namely: testing, flight suspension, public gathering restrictions and curfews were found to be essential in containing the spread of a pandemic outbreak and determine the dynamics of its spread. The number of tests conducted is important to realize the size of the outbreak in each country. For the selected MENA countries in this study, it was generally found that more confirmed COVID 19 cases resulted when a country executed more tests per million people. Fewer number of tests per million resulted in more deaths per thousand reported for the cases in Algeria, Morocco and Egypt, indicating that there might be many undetected and consequently unreported cases. For countries that conducted same number of tests, the delay of other NPI's (curfew, business / public gathering restrictions, and flight suspension), resulted in up to 67 % increase in mortality rate (deaths per 1000 reported cases). Intensifying testing programs resulted in reducing the mortality ratio in terms of deaths per 1000 reported cases by 45%.

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