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E-ISSN : 2456-1045

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RESEARCH JOURNAL

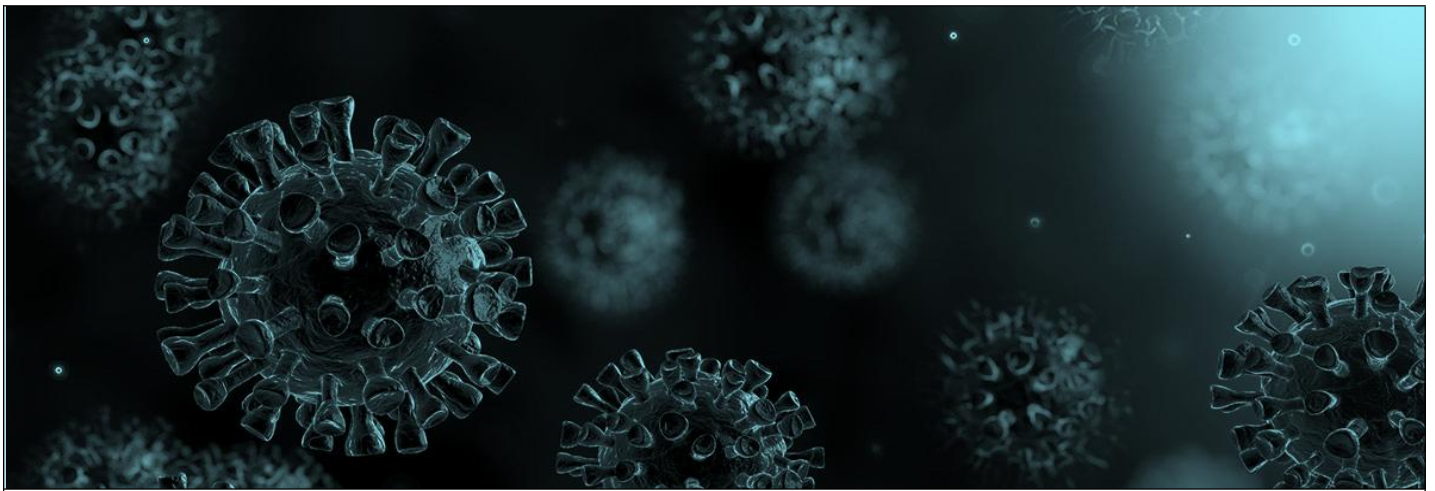
VOLUME - 48 | ISSUE - 1

ADVANCE RESEARCH
JOURNAL OF
MULTIDISCIPLINARY DISCOVERIES

APRIL
2020



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Epidemic trend and Prevention Modalities of Corona 2019 Virus Disease (COVID-19) in Morocco

ORIGINAL RESEARCH ARTICLE

NAME OF THE AUTHOR'S

ISSN : 2456-1045 (Online)
 ICV Impact Value: 72.30
 GIF- Impact Factor: 5.188
 IPI Impact Factor: 3.54
 Publishing Copyright @ International Journal Foundation
 Article Code: MDS-V48-I1-C2-APR-2020
 Category : MEDICAL SCIENCE
 Volume : 48.0 (APRIL-2020)
 Issue: 1(One)
 Chapter : 2 (Two)
 Page : 08-15
 Journal URL: www.journalresearchijf.com
 Paper Received: 11.05.2020
 Paper Accepted: 22.05.2020
 Date of Publication: 20-06-2020

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ABSTRACT

The outbreak of COVID-19 was first reported in Morocco on 2 March in Casa Anfa (Casablanca-Settat region), and subsequently spread to the other 11 regions of the country. WHO declared COVID-19 as a public health emergency of international concern on 30 January 2020. Naturally, an increasing infectious disease involves a rapid spread, endangering the health of large numbers of people, and therefore requires immediate action to prevent the disease at Community level. This is why Morocco and as soon as the first positive was declared, it put in place a series of barrier measures to counteract the disease COVID-19. This article is made by our Health-Environment research team aims at predicting and predicting COVID19 cases, deaths and recoveries through predictive modeling. The model helps to interpret the evolution of the disease and to evaluate the influence of the spread of the virus in Morocco compared to other Arab countries and European neighbours. Morocco remains in a comfortable position to control the pandemic with a mortality rate up to 100 times lower than European countries. Although these estimates are preliminary and subject to change, they are consistent with previous findings on the transmissibility of SARS-Corona virus.

KEYWORDS: COVID-19; Morocco; Arab countries, European countries

CITATION OF THE ARTICLE



Maamri A., Ben El Mostafa S., Maamri M. D. (2020) Epidemic trend and Prevention Modalities of Corona 2019 Virus Disease (COVID-19) in Morocco; *Advance Research Journal of Multidisciplinary Discoveries*; 48(2) pp. 08-15

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Open access, Peer-reviewed and Indexed journal (www.journalresearchijf.com)

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I. INTRODUCTION

Corona viruses are a large family of viruses that can be pathogenic in humans and animals. They can cause mild cold-like illnesses, while others cause more serious illnesses (such as SARS and MERS-CoV). Some corona viruses found in animals can infect humans - these are called zoonotic diseases. Human corona viruses are usually spread through droplets (coughing, sneezing) and through close, unprotected personal contact with an infected person (touching, shaking hands, etc.) or through contaminated surfaces. In December 2019, a new corona virus emerged for the first time in the city of Wuhan (Hubei Province, China), with genetic sequencing 80% similar to that of the SARS-CoV-2 corona virus. It was first provisionally designated by WHO as 2019 novel corona virus, or 2019-nCoV, before being named SARS-CoV-2 on the recommendation of the International Committee on Taxonomy of Viruses (ICTV). The disease caused by this virus was definitively named COVID-19 (Corona virus Disease - 2019) on 11 February 2020 by the World Health Organization (WHO). This new virus and disease were unknown prior to the outbreak in Wuhan, China, in December 2019.

In accordance with the provisions of the International Health Regulations (2005) - IHR (2005), this atypical pneumonia (COVID-19) was declared a public health emergency of international concern by WHO on 30 January 2020. Forty days later, on March 11, WHO declared it a pandemic. This pandemic, which goes far beyond a health crisis, spread rapidly across the planet. As of April 14, 2020, which marks the 105th day since the first cases were declared by China to the WHO, 1,937,268 cases of COVID-19 have been confirmed and more than 120,606 people have died and 459,131 people have been cured. As soon as the first cases in China were reported, WHO called on countries around the world to strengthen their surveillance systems and preparedness to deal with the possible spread of this new virus around the world.

For its part, Morocco has not been spared from this pandemic where 3568 confirmed cases including 155 deaths have been recorded as of April 23, 2020 at 6 p.m. with almost all regions affected. The first case imported from abroad was recorded on 2 March 2020 in Casablanca Anfa. Nevertheless, the Kingdom has spared no effort to deal with this public health emergency of international scope. The Ministry of Health of the Kingdom of Morocco, in close collaboration with relevant partners, has developed and implemented the "National Plan for Monitoring and Response to Corona virus 2019-nCoV Infection". This plan has set four strategic objectives: 1) Reduce the risk of introducing the virus in to the national

territory; 2) Early detection of cases and contain the spread of the virus; 3) Organize an appropriate national response: health system and other Departments; 4) Strengthen measures to prevent and control the infection in health care settings.

The Directorate of Epidemiology and Disease Control (DELM) is the central directorate of the Ministry of Health responsible for coordinating the management of the epidemic, including the collection, analysis and communication of epidemiological information concerning the evolution of the disease. At the same time, a joint national commission for epidemiological surveillance and the taking of necessary measures was set up and several measures were taken to safeguard the health and safety of Moroccan society. In this context, it was decided to declare a "state of health emergency" and to introduce measures for distancing and confinement with restrictions on the movement of persons.

During this Covid-19 epidemic in Morocco, as elsewhere in the world, epidemiological data are limited and the epidemiological parameters necessary to calibrate sophisticated mechanistic transmission models are not yet fully elucidated. Short-term real-time predictions need to be based on dynamic phenomenological models that have been validated in previous epidemics (Chowell et al., 2016; Pell et al., 2018, Bürger & Díaz, 2019). Thus, with reference to the objectives of the national monitoring and response plan for the 2019-nCoV infection, our research aims to contribute to an evaluation of the national and regional response based on barrier measures and to a further analysis of the epidemic dynamics of COVID-19 at the national and international level, in comparison with its dynamics in other countries of the Maghreb and the world.

II. MATERIALS AND METHODS

The study has a twofold aim: on the one hand, to produce mathematical models producing predictions on the key data mentioned above, based both on the daily data of Morocco and those of a selection of neighbouring European countries such as France, Italy, Spain and Belgium, arable countries such as Algeria, Tunisia, Egypt, Saudi Arabia and the United Arab Emirates. As these countries are at an advanced stage of the epidemic, it is possible to imagine the evolution of the number of deaths linked to Covid-19 in Morocco according to the different scenarios linked to these countries. Nevertheless, Morocco, unlike these countries, has adopted preventive measures at an early stage of the epidemic like those of its southern Mediterranean neighbours.

III. STATISTICAL ANALYSIS and GRAPHICAL PRESENTATION

We get daily updates of the cumulative number of confirmed cases reported for the 2019-nCoV epidemic in the regions of Morocco on the Ministry of Health website. Data updates will be collected daily at 18:00 (GMT+1), starting on 02 March 2020 and following days. Analyses include :

- (a) Calculation of case-fatality and mortality rates, incidence, prevalence
- (b) Geo-temporal analysis of viral propagation;
- (c) construction of the epidemiological curve;
- (d) evolution of COVID-19 in Morocco and in the neighbouring countries of Europe and the Arab countries and their evolution over time.

IV. RESULTS

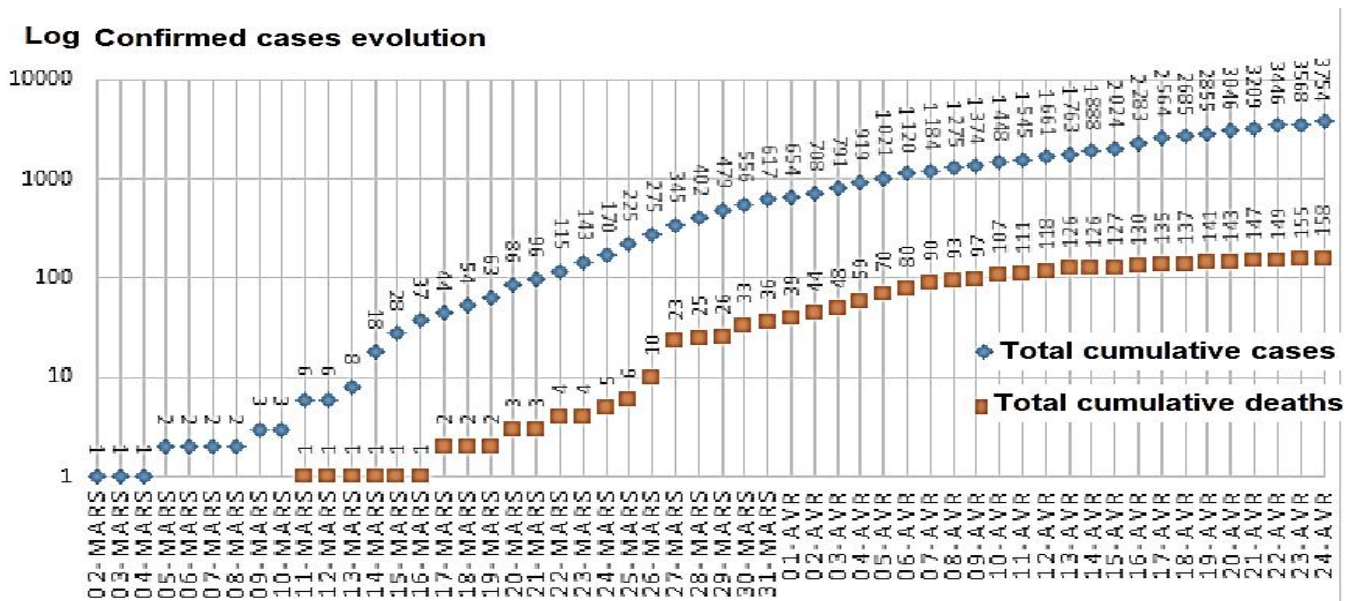


Figure 1: Trends in confirmed VIDOC-19 cases and deaths according to the number of examination days in Morocco in 20

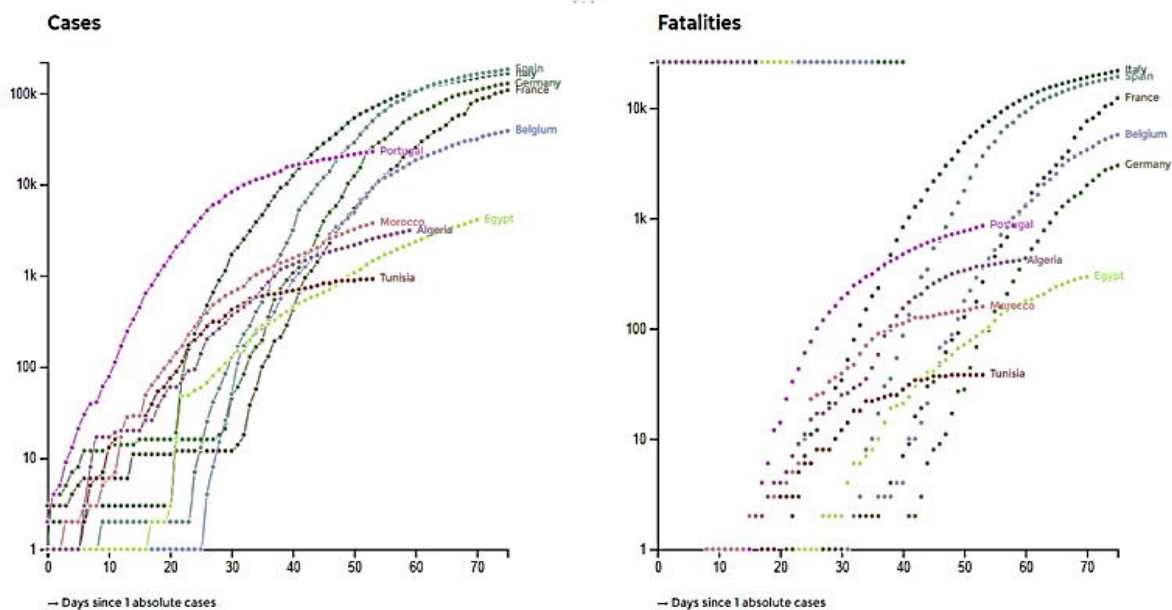


Figure 2: Evolution of the number of cases and case-fatality rate as a function of the 1st confirmed day of COVID-19 in Morocco and neighbouring countries.

Between 2 March, date of appearance of the 1st case in Morocco, the number of confirmed cases as well as the number of deaths increases exceptionally. This initially rapid increase from 13 March onwards becomes slower and slower towards the end of April (Figure 1).

It appears from figure 2 that Morocco, like other North African countries, has better mastered the evolution of the pandemic than its European neighbours. This observation is much more visible when plotting data per 1M captain on a logarithmic scale (Figure 3).

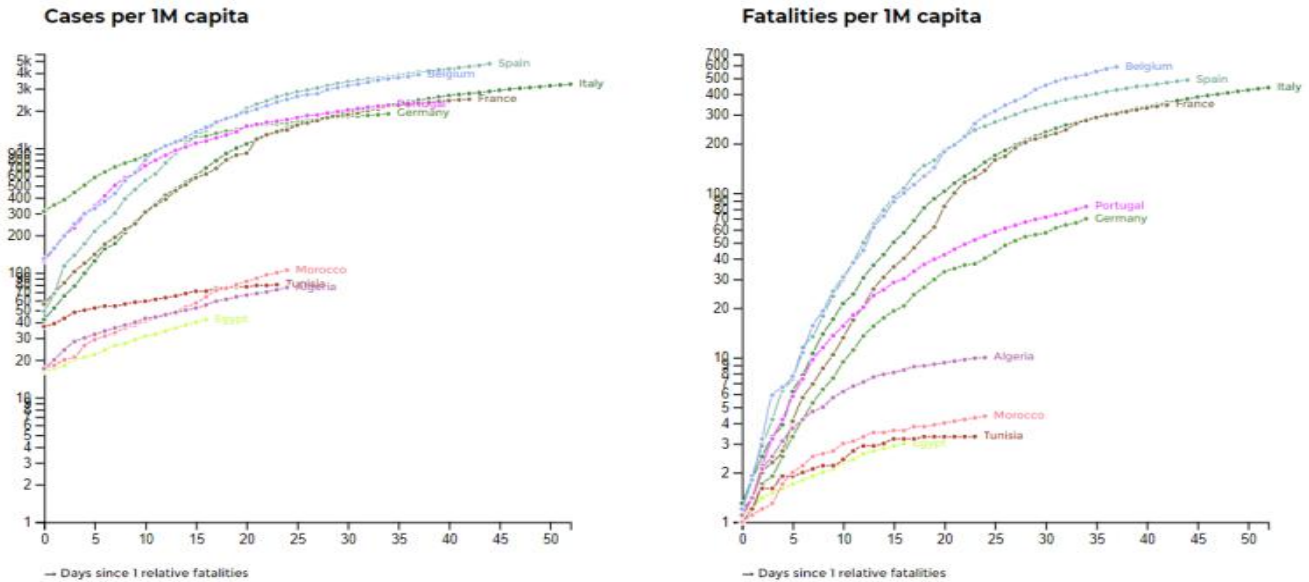


Figure 3: Evolution of the number of cases and case-fatality rate per 1M captain according to the first confirmed day of COVID-19 in Morocco and neighbouring countries.

It emerges from these graphs that the 4 southern Mediterranean countries are experiencing a much slower evolution of the COVID-19 pandemic than the northern shore countries, most of which have experienced an alarming exponential evolution of COVID-19 (Spain, Italy, France and Germany). Portugal and Belgium occupy an intermediate position.

In terms of lethality (Figure 3), Italy and Spain have the highest levels in Europe. In the Maghreb countries, Tunisia has the lowest rate, followed by Morocco, Egypt and Algeria (Figure 3). If one reports the data per 1 M inhabitants, the data becomes more meaningful. The evolution of the number of confirmed cases of COVID-19 per inhabitant allows us to distinguish two distinct groups: North African countries on the one hand and European countries on the other.

However, in terms of mortality rates, Belgium is in first place with a rate of more than 65 per 100,000 inhabitants. The Arab countries and those of the Arab Maghreb recorded the lowest rates (Figure 4).

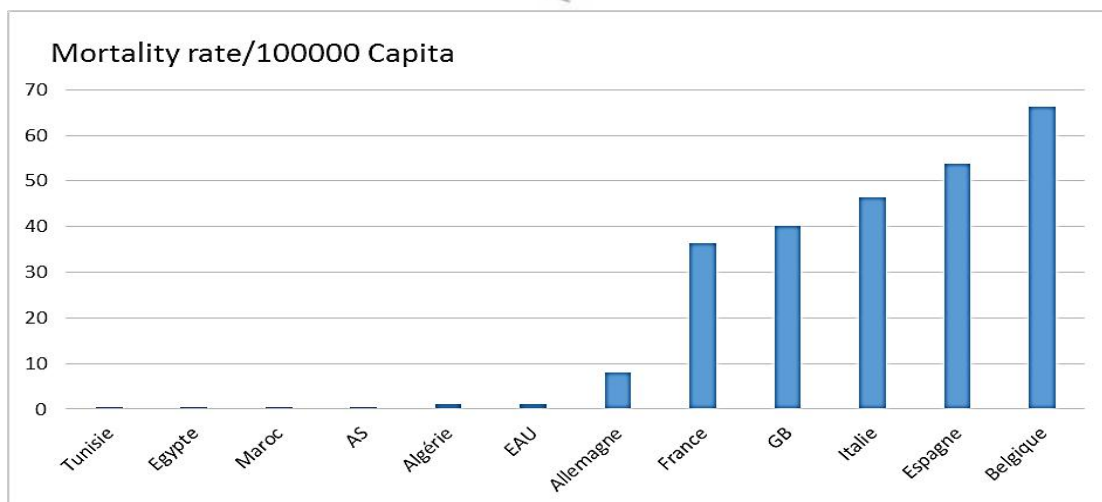


Figure 4: Evolution of the mortality rate per 100,000 inhabitants in Morocco and other countries affected by COVID-19 (data from 30 April 2020)

In comparison with Arab countries, Morocco occupies an intermediate position like other Maghreb countries. Iran remains the most affected country, followed by the other golfing countries.

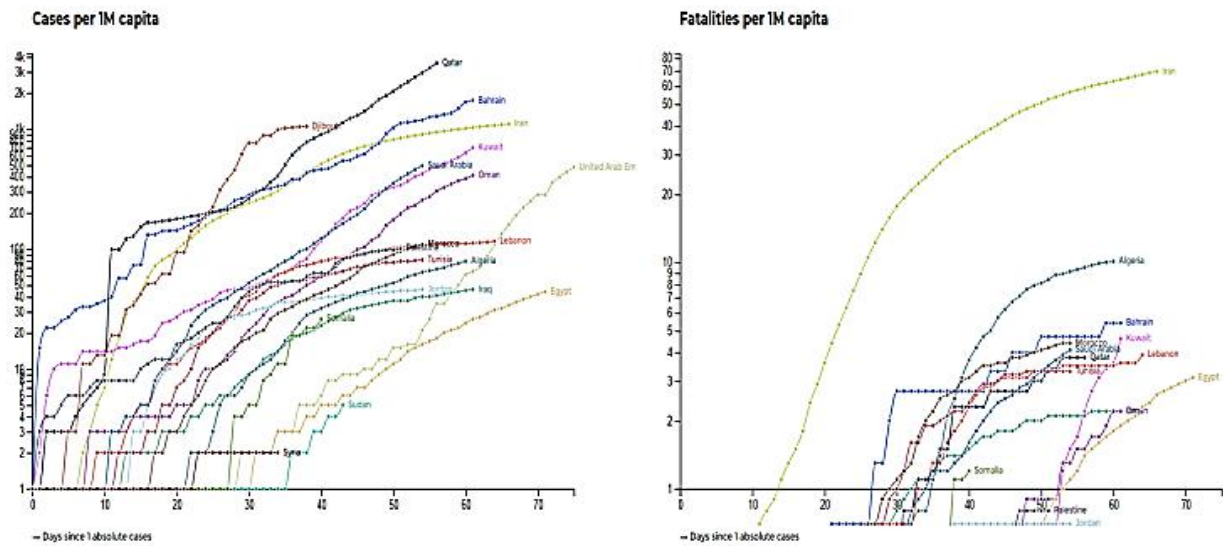


Figure 5: Evolution of the number of cases and case-fatality rate per 1M capita according to the first confirmed day of COVID-19 in Morocco and Arab countries.

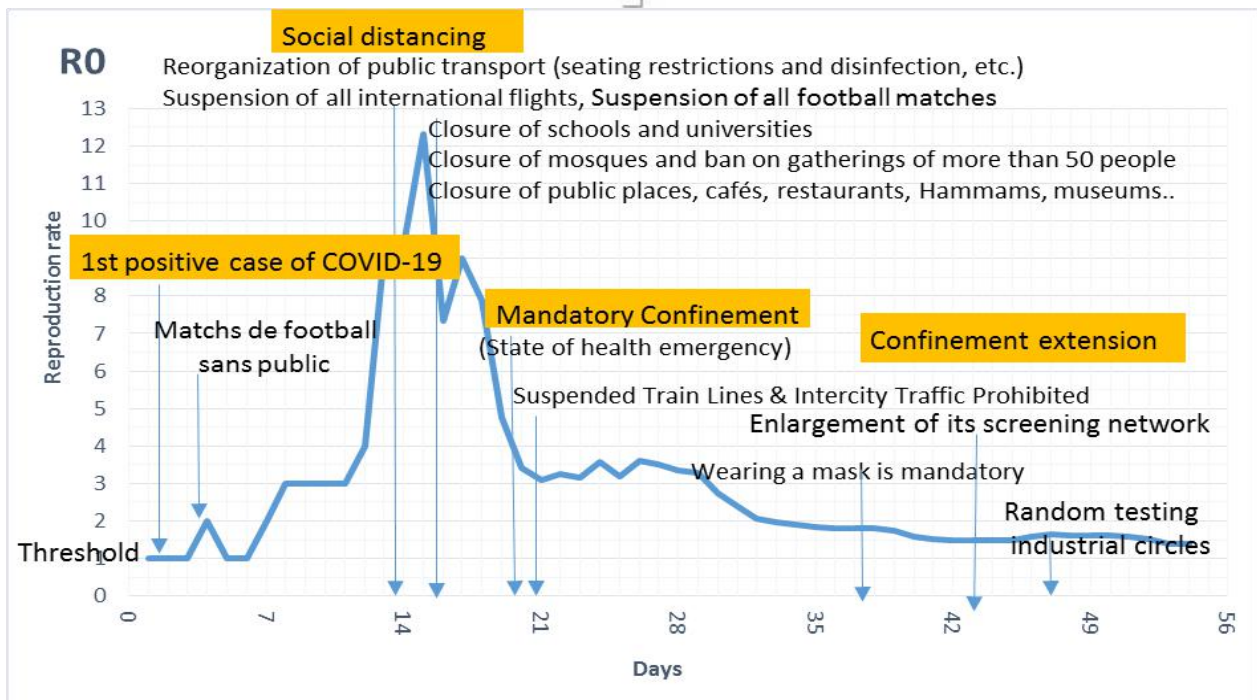


Figure 6: Representation of R0 as a function of the barrier measures introduced by Morocco

We have mentioned this concept called R0 (the number of people that a patient infects or in other words the transmission of the disease from one patient to how many patients) to illustrate the barrier effect put in place by Morocco to limit the spread of the disease. In order to reduce the epidemic, the R0 must be equal to or less than 1, which is how we are able to reduce the circulation of the virus and gradually extinguish the epidemic. This basic reproduction rate R0 is the number of secondary cases produced by an average infectious individual during his or her period of infectivity in a population consisting entirely of susceptible (non-immune) individuals. It is a threshold that varies between two basic levels:

- If $R_0 > 1$, the epidemic can set in...
- If $R_0 < 1$, there's little chance of an outbreak...

Thanks to containment, based on our estimated calculations (Figure 7), we estimate that our country has managed to increase this R_0 to a value close to 1.39 by April 24, 2020. That is to say, 10 patients infect almost 14 new people, whereas it was around 12, on March 14, 2020, i.e. 10 patients infect 120. According to our estimates, our R_0 is 2.98 on average, compared to other authors such as Ying et al. (2020) this revealed that the average R_0 was 3.28, which exceeds WHO estimates by 1.4 to 2.5. The same study revealed that the R_0 in China was estimated in some studies to be 6.47.

V. DISCUSSION

After more than a month since the appearance of the first Covid-19 case in Morocco on 2 March and the end of the first containment on 20 April, an assessment of the epidemiological situation is necessary. This is the purpose of the present research, which was carried out between March 2 and April 24 and which allows us to have visibility on the spread of the COVID-19 pandemic.

During this first analysis, it emerges that contrary to other neighbouring countries, particularly European ones, the number of confirmed cases in Morocco has increased progressively (Figs. 1, 2 and 3).

The basic reproduction rate of a disease is a central notion in epidemiology. It allows the characterization of the epidemic potential of a disease. In order to estimate this rate accurately, it is possible to take into account a very large number of factors. However, in its simplest version, the calculation depends on three essential parameters.

First factor: the period during which the disease is contagious (generally expressed in days).

The second factor is the number of different people with whom one interacts during a given period (usually expressed in "number of contacts per day").

The last factor is the probability of transmission, i.e. the ease with which contamination can occur with each "contact". This variable can be influenced by different protective measures (hand washing, wearing a mask, distancing, etc.).

Containment measures have a direct influence on the second factor mentioned above: the number of people with whom one interacts during a given period. The decrease in our daily contacts has, mathematically, led to a decrease in the number of people newly infected on a daily basis. The adoption of "barrier" measures, including stricter hygiene measures, also influenced the third factor in the equation.

The decrease in R_0 reflects a change in the dynamics of the epidemic. The infectious properties of the virus have not changed: while social interactions are increasing and barrier measures are less followed, the number of new cases per day is increasing again. This is why Morocco has introduced other barrier measures including the mandatory wearing of masks from 7 April 2020. This kept the situation under control at least until 20 April 2020. It seems very clear that all the barrier measures taken by the Moroccan government after the exponential spread of COVID-19, have contributed to lowering the R_0 to 3 initially and then 1.39 until April 24, 2020.

The first confirmed case of COVID-19 was announced on March 2, 2020. Announcements follow each other almost daily from that date. Rapidly, the population tested positive rose from 33 people on March 3 to 387 on March 20. The WHO declared the state of pandemic on March 11th and the first death in Morocco was announced on March 12th. From this date, the analysis of the R_0 in Morocco (fig. 7) shows that the situation is starting to worsen as the reproduction rate has risen above 4, which means that the spread is accelerating and the health system will be overwhelmed if no action is taken. The Moroccan government's reaction was immediate. On March 13, Morocco announced the closure "until further notice" of air and sea links to France and Spain, as well as its land borders to prevent the spread of Covid-19. Yet our country was still at stage 1 of the pandemic. A new stage was reached on 14 March, when the number of positive cases doubled overnight (13 March: 8 confirmed cases, 14 March: 18 cases, 16 March: 37 cases). Morocco has closed to the public, from 6 p.m. on 16 March and until further notice, cafés, restaurants, cinemas and theatres, party halls, clubs and sports halls, hammams, gambling halls and community grounds. However, the country is moving to another alert level with the announcement, on 18 March, of the discovery of local outbreaks of contamination. The appearance of clusters generally confirms the passage to stage 2 of the pandemic. Morocco subsequently announced compulsory containment and a state of public health emergency, which before today was a partial and voluntary containment. Morocco has so far been in anticipation by taking decisions that fall under stage 2 or 3 while it was only at stage 1, such as the suspension of air links from March 14, 2020. Any gathering, meeting or activity involving more than 50 people simultaneously has been prohibited until further notice. As a result, mosques were also closed from 16 March. Anderson et al (2020) predict that social distancing on a larger scale is likely to be necessary, as has been implemented in China. This prevents the transmission of symptomatic and non-symptomatic cases, thereby flattening the epidemic and pushing the peak further into the future. Social distancing on a larger scale allows time for health

services to treat cases and increase capacity and, in the longer term, to develop vaccines and treatments. Containment could be targeted to particular areas, schools or mass gatherings. Sohrabi et al (2020) confirmed that only containment methods are among the solutions to stop the spread of the virus.

In addition, a series of organizational measures relating to the management of public transport were also taken as of 14 March to contain the disease. Indeed, and in order to preserve the health and safety of citizens, places in large taxis have been limited to three instead of six. Buses and trams must no longer exceed their maximum capacity, i.e. the number of seats available. In addition to these measures restricting the number of passengers, a major disinfection operation of public transport means has been launched to combat the spread of the Corona virus.

Anderson et al (2020) confirm that in the face of a lack of a vaccine, what is currently left for mitigation is more mandatory voluntary quarantine, stopping mass gatherings, closing educational institutions or workplaces where infection has been identified, and isolating households, towns or cities. Some of the lessons learned from the influenza A analyses apply to VIDOC-19, but there are also differences. Social distancing measures reduce the value of the effective reproduction number R . With an early epidemic value of R_0 of 2 - 5, social distancing should reduce transmission by about 60% or less.

Despite the good results obtained, Morocco has continued in its policy of anticipation by adopting the compulsory wearing of masks from 7 April, increasing the number of screening tests but also extending the confinement for another 30 days. These incentives have had only positive repercussions on the control of the disease despite the appearance of some familiar outbreaks at the penitentiary and industrial level. To remedy this, Morocco has initiated new draconian measures at the enterprise level for the implementation of barrier measures and the protection of employees, but also to carry out random screening at these institutions. These anticipatory measures have enabled Morocco to control the evolution of the pandemic beyond its health capacities and its health system has shown a good resilience despite the inefficiencies compared to other countries in Europe or the Arab world (golf). However, this comparison must be taken with certain limitations. Different countries have implemented different testing strategies and also have different testing capacities. It is reasonable to assume that most countries do not report the actual number of cases and that some countries have a large margin (such as China). This makes it difficult to compare countries with each other. It should therefore be used with caution.

VI. CONCLUSION

Morocco, thanks to its anticipation in the management of the COVID-19 disease, has shown the effectiveness of preventive measures taken at the population level. At the time of writing this article, the case-fatality rate is 3.8%. This rate tends to decrease significantly over time. The mortality rate is even lower, of the order of 0.47, which is much lower than in the other European and Arab countries except Tunisia.

Thus, in order to keep control of this pandemic until its total disappearance, and in the absence of a vaccine against covid-19, it is sufficient to adopt a series of "barrier gestures" to protect oneself for the time being. It is therefore necessary to apply basic hygiene measures:

- ✓ Wash your hands regularly with soap and water, or a hydro-alcoholic solution;
- ✓ Practise social distancing measures.
- ✓ Cough and sneeze into a tissue or into the crook of the elbow if no tissue is available;
- ✓ Dispose of your tissues in a closed garbage can;
- ✓ Avoid gathering as much as possible and forbid friendly and family gatherings;
- ✓ Leave the house only for essential shopping, wash your hands before and after and keep 1 meter away from other customers by queuing at the checkout;
- ✓ Wear a mask outside
- ✓ Avoid travelling or engaging in sports or leisure activities in public places.

VII. ETHICS

Not applicable.

VIII. LES CONTRIBUTIONS DE L'AUTEUR

BS and MMD performed forecasting and data analysis; MA retrieved and managed data; and all authors contributed to the writing and editing of subsequent versions of the manuscript. All authors read and approved the final manuscript.

IX. DÉCLARATION D'INTÉRÊTS CONCURRENT

The authors do not declare any competing interests.

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