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Populations' Behavior Toward Covid-19 Safety Measures: Evidence from Algeria, Morocco, and Tunisia

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Abstract
The present study aims to analyze the populations' behavior toward COVID-19 safety measures in each of Algeria, Morocco, and Tunisia. In this direction, a particular focus is put on which safety measures are observed and which category of people is most likely to observe them. To answer these questions, household data provided by Economic Research Forum (ERF) rapid phone survey are used for both Morocco and Tunisia. However, the used data for Algeria are provided by a household survey conducted by the Research Center of Applied Economics for Development (CREAD). The obtained results show some similarities among the population's behavior of these countries. In fact, in all these countries, women are those who mostly observe the safety measures. The educational level also plays a role in these populations' behavior, nevertheless, its impact on these behaviors differs from a country to another. Moreover, an ordred probit model is estimated to identify the determinants of the observed safety measures intensity in each country. In this regard, it is shown that women and elderly mostly comply with the barrier methodes, nevertheless men and youth are those who use these measures more intesenvily. Furthermore, simulations results show that the percentage of Moroccans observing three safety measures converges to 80%, against 59% in Tunisia, and only 5% in Algeria.

Keywords
Populations' behavior; COVID-19 outbreak; safety measures; MENA region.

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Résumé
La présente étude vise à analyser le comportement des populations envers les mesures de sécurité COVID-19 en Algérie, au Maroc et en Tunisie. Dans ce sens, un accent particulier est mis sur les mesures de sécurité qui sont respectées et sur les catégories de personnes les plus susceptibles de les observer. Pour répondre à ces questions, les données sur les ménages fournies par l'enquête téléphonique rapide du Forum de recherche économique (ERF) sont utilisées pour le Maroc et la Tunisie. Cependant, les données utilisées pour l'Algérie sont fournies par une enquête auprès des ménages réalisée par le Centre de recherche en économie appliquée pour le développement (CREAD). Les résultats obtenus montrent certaines similitudes entre les comportements des populations de ces pays. En effet, dans tous ces pays, ce sont les femmes qui respectent le plus les mesures de sécurité. Le niveau d'instruction joue également un rôle dans les comportements de ces populations, néanmoins, son impact sur ces comportements diffère d'un pays à l'autre. De plus, un modèle probit ordonné est estimé pour identifier les déterminants de l'intensité d'utilisation des gestes barrières dans chaque pays. À cet égard, il est démontré que les femmes et les personnes âgées respectent majoritairement les gestes barrières, néanmoins les hommes et les jeunes sont ceux qui utilisent le plus intensément ces mesures. Par ailleurs, les résultats des simulations montrent que le pourcentage de Marocains respectant trois mesures de sécurité converge vers 80%, contre 59% en Tunisie, et seulement 5% en Algérie.

Mots-clés
Covid-19, Gestes barrières, Comportements des populations, régions MENA.

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Cet article fait partie de l'appel à propositions lancé par le partenariat de recherche AFD-ERF Covid-19 MENA Monitor Research Partnership. Les auteurs tiennent à exprimer leur gratitude au Dr Caroline KRAFFT et au Dr Cecilia POGGI qui ont fait des remarques très utiles contribuant à l'amélioration de l'article. Ils adressent également des remerciements particuliers à toute l'équipe de l'ERF, expressément à Passsainte ATEF et Ramage NADA qui ont géré l'ensemble du processus.

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Introduction

Almost two years after the emergence of the new SARS-CoV 2 causing the Covid−19 pandemic, the crisis management is still challenging. Indeed, even with the arrival of the vaccine, the use of the safety measures announced by the authorities is still an important mean to reduce the virus spread. However, this efficiency depends strongly on how people apply them i.e. the number of measures that are used and which of them? In this direction, Li et al. (2020) showed through a quantitative analysis simulation the importance of the percentage of people wearing the face mask in the virus spread reduction. Also, the authors stated that the combination of wearing masks to the other measures such as social distancing can efficiently replace the shelter-in-place. Furthermore, Lin et al. (2020) studied the correlation between the Google keywords search "wash hands" and "face mask" and the increased number of Covid−19 infections in 21 countries. The authors found that the increase number of these keywords search from January 19 to February 18, 2020 is correlated with a lower spreading speed of the virus from February 19 to March 10, 2020. Other studies (Courtemanche et al., 2020; Stein, 2020; Siedner et al., 2020) were conducted concerning the social distancing and demonstrated its potential to reduce the virus spread speed. However, this latter measure can negatively impact the psychological aspect of people (Venkatesh and Edirappuli, 2020).

In order to increase public awareness of these measures, the authorities must increase their credibility on one hand and choose the right communication strategies on the other hand (Lunn et al., 2020). Nevertheless, the elaboration of efficient strategies needs an important background concerning the populations' perception on Covid−19. Several studies were conducted all around the world to analyse and understand the impact of the Covid-19 pandemic on various aspects (social, economic, health, etc). In the United Kingdom, Lamarche (2020) studied the perception of 300 UK residents toward the Covid−19 precautions and their trust in their governments management. In Pakistan, Mahmood et al. (2020) estimate that the asked people, through a survey, had a good knowledge about the Covid−19 disease. Concerning the safety measures, the authors found that 39.9% wash their hands every hour, 56.9% wear surgical masks, and 65.2% practice social distancing. Ilesanmi and Afolabi (2020) showed a low correlation between the likelihood to contract the Covid−19 and the practices to prevent it in selected urban communities of Ibadan, Oyo State, Nigeria. Also, they noticed that the most reported practices to prevent the Covid−19 are the wearing mask (64.5%) followed by the social distancing (48%). Abaluck et al. (2021) conducted an epidemiological study in rural Bangladesh, from November 2020 to April 2021 among 600 villages and 342183 adults. In this direction, they studied the impact of several strategies on the changes in symptomatic SARS−CoV 2 infection. These strategies include mask's distribution at a household level accompanied by communication about the value of mask wearing, and promoting the mask wearing with reminders at public places. In their results, it is shown that, the used strategies contributed to increase the mask wearing ,and to reduce the virus spread. Also, they found that women wear masks more frequently, but men respond more to awareness actions. Other studies concerning Covid−19 impacts are found all over the world, as in Nepal (Singh et al., 2020; Samadarshi et al., 2020), Ethiopia (Shewasinad Yehualashet et al.,

2021), Saudi Arabia (Alkhaldi et al., 2021), and China (Xie et al., 2020).

In the selected MENA countries namely, Algeria, Morocco, and Tunisia, researchers investigated the Covid-19 crisis on several aspects. In this direction, Algerians' perception on Covid-19 dangerousness, and their behaviors in terms of mobility during, and after lockdown were addressed in (Idres et al., 2020). The authors showed that most Algerians consider Covid-19 as a serious illness, but their mobility is not affected by their Covid-19 related danger perception. In addition, the authors found through numerical simulations that, according to Algerians mobility, the risk of a high virus spread after lockdown stays high even with 61% of people observing all the safety measures. Other studies concerning the virus spread prediction in Algeria are done. Bentout et al. (2020) estimated through an epidemic model the basic reproductive number R_0, and found that it equals 4.1 i.e. one infected person can contaminate four other persons during the entire infection period. Furthermore, the authors conducted numerical simulations, and conclude that strict measures such us those applied in China would be necessary to contain the virus propagation in Algeria. In the same direction, Zhao et al. (2020) showed that a moderate control rather than a strict control will induce an increase of infected people by $1.43 - 1.55$ times, and will delayed the epidemic control by about 10 days. Kadi and Khelfaoui (2020) studied the relationship between the virus spread and the population density, and found that there is a strong correlation between them in Algeria. Moussaoui and Auger (2020) for their part, showed that the earlier the government applies restrictions such as self$-$isolation or quarantine, the lower would be the cumulative number of infected persons. Furthermore, the governmental actions to prevent the virus spread in Algeria are summarized in Lounis (2020).

In Morocco, we essentially find studies dealing with the quality of life during the Covid-19 pandemic. Idrissi et al. (2020) studied the psychological impact of the lockdown due to Covid-19 crisis on Moroccans, and its related sleep disorders. The authors found that, during this period, sleep disorders, anxiety, and depressive symptoms are highly noted in Moroccan population. Samlani et al. (2021), showed through an online survey conducted among 279 Moroccan citizens, that the quality of life and health well-being of people with chronic health problems are more impacted by the Covid-19 crisis. Other studies dealing with the crisis' impact on the country's economics are done. Firano and Fatine (2020) found that, the containment policy contributes to reduce the virus spread, keeping a moderate repercussion on the Moroccan's economy. Moreover, the authors stated that, even with stricter containment, Morocco will be able to face the resulting economic crisis. Bossenbroek and Ftouhi (2021) focused on female agricultural wage-workers, and highlighted their financial and psychological hardship, which became rougher during the Covid-19 crisis. Furthermore, Zakary et al. (2020) developed a mathematical model to assess the virus spread in countries under quarantine. The authors considered two categories of people: those who respect the quarantine, and those who does not. Then, they applied this model to the Moroccan case and conducted several simulations to see the impact of control strategies on reducing the category of people who underestimates the quarantine. Bouchnita and Jebrane (2020) also used a mathematical model to reflect the virus spread dynamic, and

showed that adopting the two measures: movement restriction and mandating the mask wearing, can reduce the number of infected cases by 64%.

In Tunisia, Talmoudi et al. (2020) used the Maximum Likelihood method through data collected from the Observatory of New and Emerging Diseases of Tunisia, to assess the dynamic of the reproductive number R_t. The authors showed that this number decreases from 3.18 to 1.77, after the lockdown interventions. Slimani et al. (2020) studied the relationship between the physical activity and quality of life during the confinement. They found that people with considerable physical activity have better psychological, social, and environmental quality of life. Slama et al. (2021) focused their study on the psychological aspects of healthcare workers. The authors highlighted the importance of providing adequate personal protective equipment, good communication with the team and the managers, and family support to reduce these workers stress. Fekih-Romdhane et al. (2020) also studied the psychological impact of the Covid-19 on medical residents from all over Tunisia, with 43.8% of them working in Covid-19 isolation units. The authors found that 30.5% of the participants reported severe levels of depression, 24.3% suffer from anxiety, and 18.6% are stressed.

In the present work, we focus on the use of the safety measures namely: social distancing, wearing a mask, and washing hands in selected MENA countries: Algeria, Morocco, and Tunisia. The main questions of interest are then:

(i) How do the populations of these countries behave regarding these safety measures?

(ii) How do these behaviors evolve over time?

(iii) And which socioeconomic variables are determinant in these behaviors?

Also, these behaviors are analysed in terms of used safety measures kind and number. As far as we know, no studies considering these questions in the aforementioned countries were treated in the literature.

The rest of this paper is outlined as follows: Section 1 is devoted to the methodology whereas the obtained results are given in Section 2. A discussion is presented in Section 3 and finally a conclusion is drawn in the last section.

1. Methodology

1.1. The used data

To reach the aim of this study, two distinctive data sources are used:

1. Rapid phone survey (household data) of ERF Covid-19 MENA Monitor, and
2. Computer-Assisted Personal Interviewing (CAPI) household survey, carried out by the Center of Applied Economics for Development (CREAD).

The ERF Covid-19 MENA Monitor is used to provide Moroccan and Tunisian data, whereas the CAPI-CREAD is used for Algerian ones.

The use of different data sources requires special attention regarding questions' formulation used in the questionnaires and interviews dates.

The studied questions are those dealing with the use of safety measures (social distancing, wearing a mask and washing hands). These questions are considered in both surveys (ERF and CREAD), nevertheless their formulations are quite different. Indeed, in the ERF survey these questions are asked as follows:

1. Do you try to stay at least one meter away from people when you are out side the house?
2. Do you wear a mask when outside the house?
3. Do you wash your hands with soap more often than you did before Covid-19?

Thereby the asked people answer by "Yes" or "No". However, in the Algerian survey the questions are presented as follows:

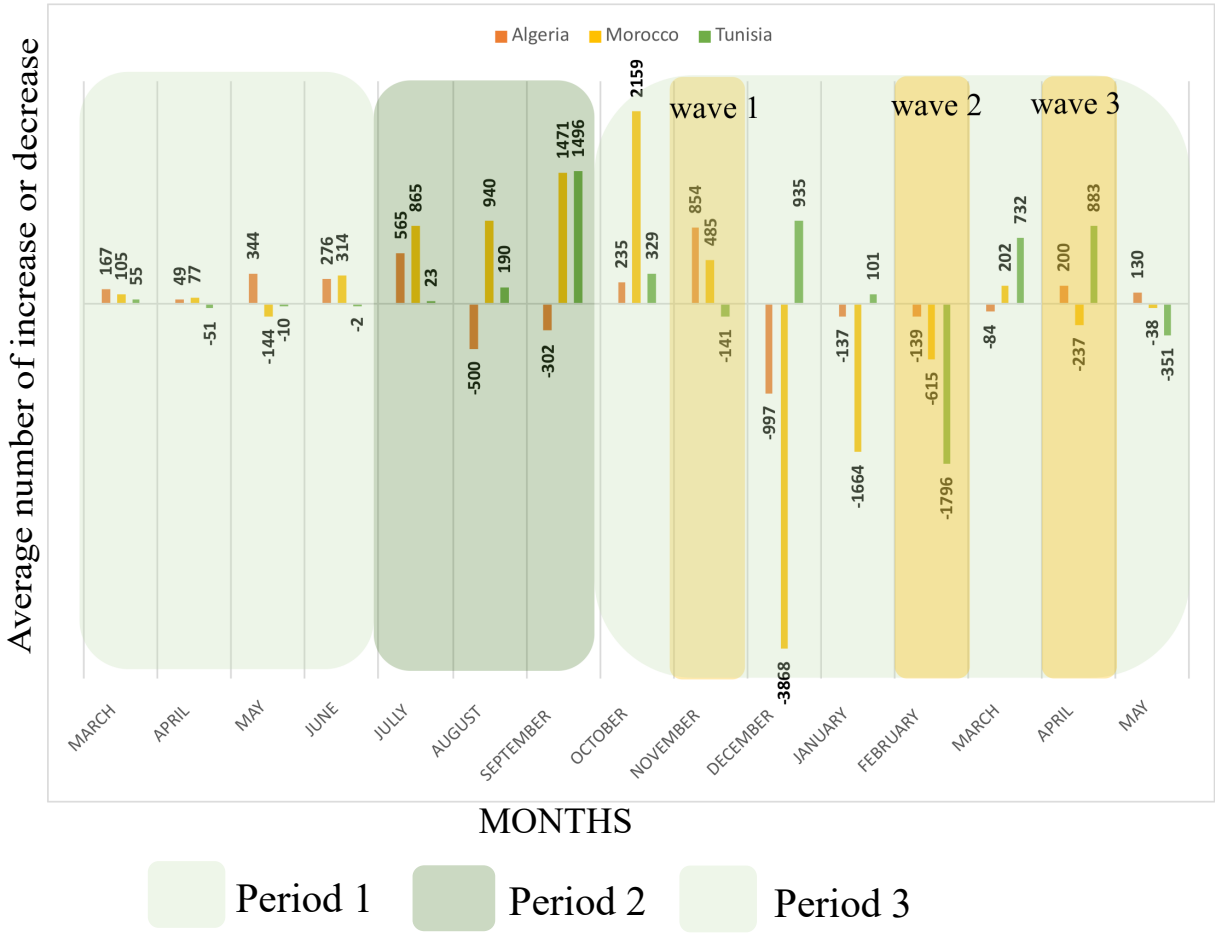
1. Do you observe the distancing measure?
2. Do you wear a surgical mask ?
3. Do you use hydroalcoholic gel?

The proposed answers are then "Yes, frequently", "Yes, sometimes" and "not at all". To harmonize the answers with the ERF version, the modalities "Yes, frequently" and "Yes, sometimes" are regrouped and considered as a "Yes" answer, whereas the "not at all" is considered as a "No" answer. Furthermore, for the ERF survey these questions were asked within three waves over time (in November 2020, February 2021 and April 2021). Nevertheless, the Algerian survey was conducted from May $23^{rd},\ 2021$ to June $15^{th},\ 2021$ and the aforementioned questions were asked by period i.e Algerian people were asked if they observe these measures during each period of the following: period 1, from March 2020 to June 2020; period 2, from July 2020 to September 2020 and the third period from October 2020 to May 2021.

To evaluate the health situation within these waves/periods, we have computed the monthly average number of confirmed cases' increase or decrease in each country (Figure 1). These numbers are obtained using the WHO Covid-19 dashboard[1] by computing the mean over a month of the weekly increase or decrease of the confirmed cases. The negative values correspond to an average number of confirmed cases lower than the average number of confirmed cases of the previous month.

[1]number of weekly increase or decrease available at https://covid19.who.int/

Figure 1: Monthly average number of confirmed cases increase or decrease in Algeria, Morocco, and Tunisia, from March 2020 to May 2021



Source: Computed by the authors using WHO data

1.2. Data analysis

We proceed to the data analysis in two steps. At the first step, the focus is made on the used safety measures separately. Secondly, the data are considered at an aggregate level, where the number of observed measures per person is the variable of interest.

First step

Let us consider the following variables notations:

Table 1: table of variables' notations

Y_1	The use of the safety measure "social distancing"
Y_2	The use of the safety measure "wear a mask"
Y_3	The use of the safety measure "wash hands"
z_1	The gender
z_2	The age
z_3	The educational level
z_4	The residence region

The first analysis aims to highlight, for each country, the most used safety measure within each wave/period. Then, studying the effect of the variables: gender(z_1), age (z_2), educational level (z_3) and residence region (z_4)on the behavior of each country's population. In this direction, for each wave/period, the dependence between the variables $(Y_i, z_j), \forall\ i = \overline{1,3},\ \forall\ j = \overline{1,4}$ are studied through Chi-square statistical tests. The obtained results allow us to see whether these basic social variables $-$i.e gender, age, educational level and residence region$-$ affect the populations' behavior toward the use of each safety measure. Also, even when there is no significant dependence between a couple of variables, the trends of the used safety measures following these basic variables, over time, are obtained. Furthermore, two variables Δ_1 and Δ_2 are calculated in order to compare the used measures variations among the three countries, such as:

$$\Delta_1 = N_2^i - N_1^i,\ \ \forall i \in \{1,\ \ 2,\ \ 3\}, \tag{1}$$

and

$$\Delta_2 = N_3^i - N_2^i,\ \ \forall i \in \{1,\ \ 2,\ \ 3\}. \tag{2}$$

Where, N_j^i represents the percentage of people observing the i^{th} safety measure within the j^{th} wave.

Second step

More generally, we consider the number of safety measures that are used by each person (for each country and each wave/period). To this end, let x_i^j be the variable representing if the i^{th} safety measure is observed within the j^{th} wave/period, or not, i.e:

$$x_i^j = \begin{cases} 1, & \text{if the } i^{th} \text{ safety measure is observed within the } j^{th} \text{ wave/period;} \\ 0, & \text{otherwise. } i = \overline{1,3}. \end{cases}$$

and let us consider the variable S^j defined as follows:

$$S^j = \sum_{i=1}^{3} x_i^j,\ \ j = \overline{1,3}. \tag{3}$$

The variable S^j can take the values $\{0,\ \ 1,\ \ 2,\ \ 3\}$ following the number of safety measures that are observed within the j^{th} wave/period.

Furthermore, a variable Mn^j that represents whether a person observes at least one safety measure within the j^{th} wave/period is defined as follows,

$$Mn^j = \begin{cases} 1, & \text{if } S^j \geq 1;\ j = \overline{1,3}, \\ 0, & \text{if } S^j = 0; \end{cases}$$

In addition, transition graphs are constructed to see how people changes there behavior in term of used safety measures' number, from a period of time to another. In other words, they describe the passing dynamic from a given number of used safety measures to another, between two consecutive periods of time. These transition graphs are composed by nodes (vertices), also called states, representing a possible value of the number of observed safety measures. These nodes are linked by arcs that represent the possibility to move from a node to another. Also, a conditional probability which represents the probability to move from a node to another is associated with each arc. Formally, the transition graphs are defined as follows:
Let the graph $G = (V, E, W)$ be a weighted graph such that:

- the set of vertices $V = \{v_i,\ \ i = \overline{0,3}\}$ represents the set $\{0,\ \ 1,\ \ 2,\ \ 3\}$ of possible values of the number of safety measures that are observed;
- the arcs set $E = \{e_{i,j},\ \ i = \overline{0,3},\ \ j = \overline{0,3}\}$ represents the set of transitions from the state v_i to the state v_j;
- the weight set $W = \{P_{i,j},\ \ i = \overline{0,3},\ \ j = \overline{0,3}\}$ represents the set of probabilities $P_{i,j}$ that a person observes v_j safety measures knowing that she/he observed v_i safety measures previously.

As we use the data of three waves/periods, then two transition graphs are constructed for each country. The first one G^1 concerns the transition from the first to the second wave/period. Hence, The set W^1 represents the conditional probabilities $P^1_{i,j}$ that a person observing v_i safety measures at the first wave/period, increases or decreases this number to v_j at the second wave/period. Mathematically, these probabilities are given by the following formula.

$$P^1_{i,j} = P(S^2 = j/S^1 = i),\ \ i = \overline{0,3}, j = \overline{0,3}. \tag{4}$$

The second graph G^2 concerns the transition from the second to the third wave/period where the set W^2 represents the conditional probabilities $P^2_{i,j}$ that a person observing v_i safety measures at the second wave/period, increases or decreases this number to v_j at the third wave/period. Mathematically, these probabilities are given by the following formula.

$$P^2_{i,j} = P(S^3 = j/S^2 = i),\ \ i = \overline{0,3}, j = \overline{0,3}. \tag{5}$$

To see what would happen if the populations continue to act (in term of used safety measures number) as they do, simulations are done. These simulations are based on the aforementioned transition graphs and summarized in the following steps:

- Step 0: calculate the proportions of people at each state of the transition graph i.e. proportion of people respecting respectively 0, 1, 2, and 3 safety measures.
- Step 1: for each state, compute the proportions of people moving to the other states.
- Step 2: update the proportions of people at each state.
- Step 3: repeat steps 1 and 2 until a given number of iterations.

Finally, we estimate series of discrete choice logit model on a binary outcome "observed safety measures" and ordered probit model on an ordinary outcome "intensity of observed safety measures". Both models are run separately, and by gender for both Morocco, and Tunisia. In addition, the ordered probit model is run for Algeria, we estimated the same model separately for men and women for each of the three periods (P1: March $2020-$June 2020, P2: July $2020-$September 2020, P3: October $2020-$ May 2021). Concerning the logit model, the dependant variable is "whether the individual respect at least one of the safety measures" and is represented by the aforementioned variable Mn. For the ordered probit model the dependant variable is "the intensity of observed safety measures" given by the variable S defined above. Moreover, the explanatory variables include,

$1)$ a number of demographic variables such as age, gender, marital status, education level, and area of residence,

$2)$ household characteristics such as household size, number of children under age six in the household and number of children enrolled in school,

$3)$ working status,

$4)$ the variable worried about being infected with Covid-19 that we suspect endogenous so we estimate all models with and without this variable,

$5)$ waves of carrying out the survey.

These explanatory variables are defined as follows:

- The dummy variable for gender is equal to 1 for men and 0 for women.
- Four categories of Age: $18-24$ years, $25-34$ years, $35-54$ years and $55-64$ years.
- Four categories for the individual's levels of education are considered: less than basic, basic, secondary and higher education. Less than basic level of education includes the illiterate and those with primary level education.
- The dummy variable for the area of residence is equal to 1 if the individual lives in an urban area and to 0 if he/she lives in a rural area.
- For the marital status, two categories are controlled: Never married and Ever married (currently married or divorced/widowed).
- Household size, number of children under age six and number of children enrolled in school are continuous variables.
- Five categories for the variable working status: non-wage, formal, Informal, unemployed and out of labor force.
- Four categories for the variable worried about being infected: Not at all| worried, A little worried, Rather worried and Very Worried.
- For the variable waves we have three waves for each country.

2. Results

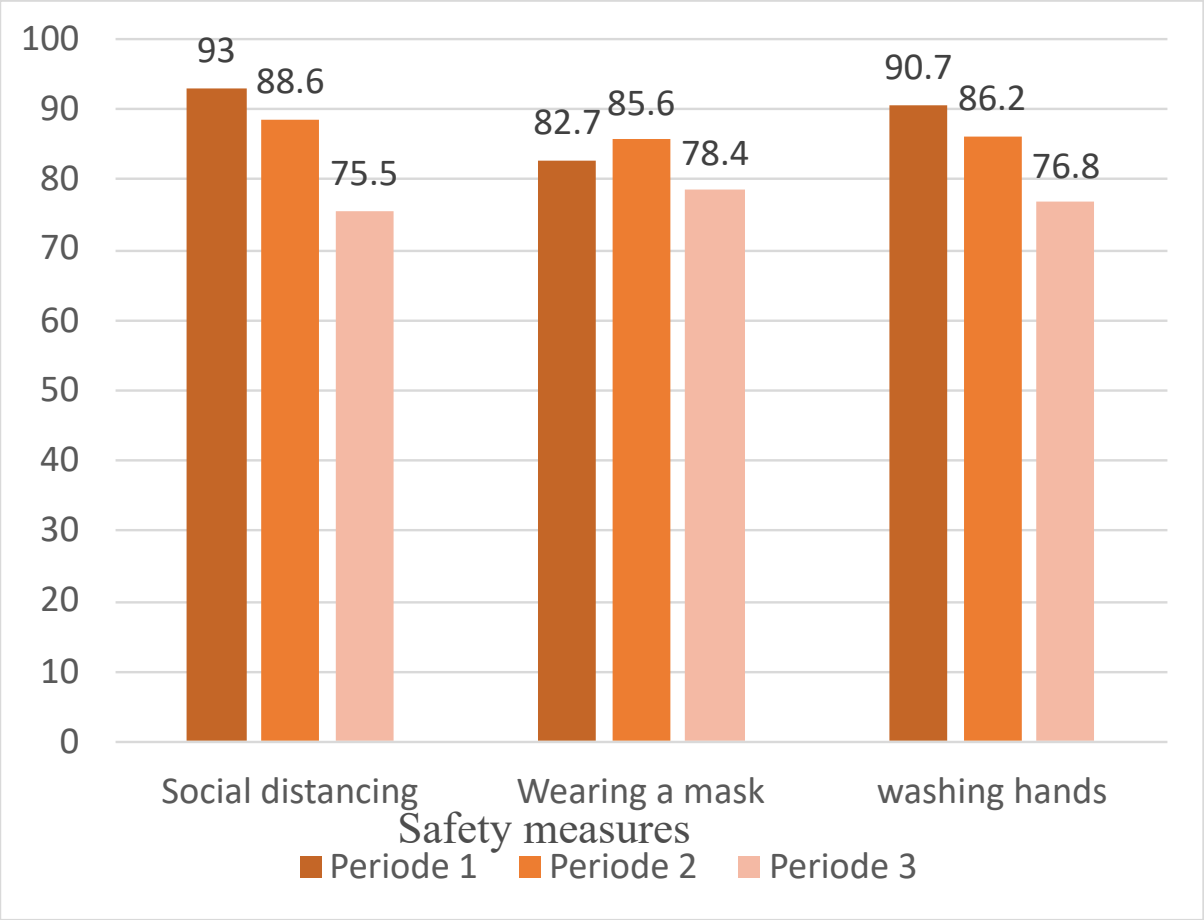
2.1. Who does respect the safety measures?

First, we perform the analysis for each country separately, then a comparison among the three countries is done.

2.1.1. Algeria

In the first period of the pandemic, 93% of Algerian people stated that they have observed the "social distancing" measure, making of this measure the most observed one. With 90% of people observing it, the "washing hands" measure is the second one to be mostly observed; whereas only 85.6% observe the measure "wear a mask". Over the time, the percentage of people observing both "social distancing" and "washing hands" decreases, however the percentage of people wearing a mask increases by 2.9% in the second period, then decreases again to reach 78.4% in the third period (see Figure 2). One can remark that, in the third period, the ranking of the observed measures is completely reversed compared to the first period. Indeed, 17.5% of Algerian people abandoned the measure "social distancing" and 13.94% abandoned the measure "washing hands".

Figure 2: Algerian and safety measures(%)



Source: Computed by the authors using CAPI-CREAD survey data

- Gender analysis

The obtained results using Chi−square tests show that the sex effect differs regarding the period and the safety measure kind (see Table 2). For instance, the sex has no significant effect on the measure "wear a mask" at the first period, but is very significant at the two last periods.

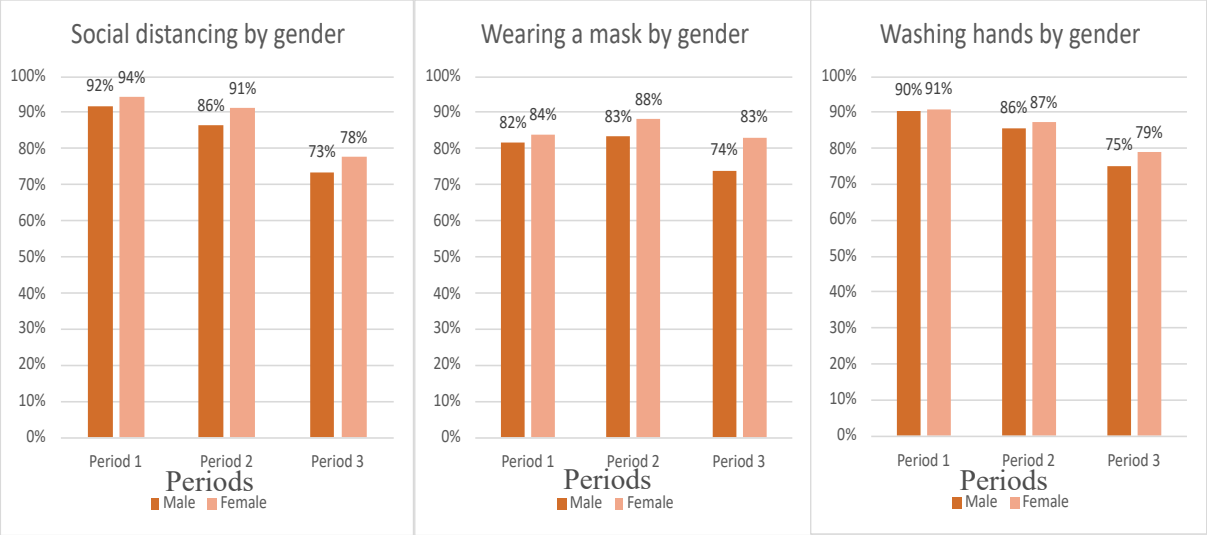
Table 2: The obtained p−values between the gender and each safety measure using Chi−square test in Algeria

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Period 1	0.033	0.145	0.374
Period 2	0.002	0.005	0.215
Period 3	0.033	0.000	0.049

Moreover, the analyzed results by gender show that women are more respectful than men. In fact, the percentage of women observing each measure is greater than the percentage of men doing it, whatever the period. Concerning the most used safety measure, we see a common behavior between men and women in the two first periods, where both of them mostly use social distancing. However, in the third period, men mostly use washing hands

measure, whereas women mostly use wearing mask measure. Over the time, the evolution of these percentages follows the same trend for both men and women. In this regard, we notice a decreasing percentage of both men and women using social distancing or washing hands measures; while these percentages reach their maximum in the second period for wearing mask measure (see Figure 3).

Figure 3: Safety measures by gender in Algeria



Source: Computed by the authors using CAPI-CREAD survey data

- Age analysis

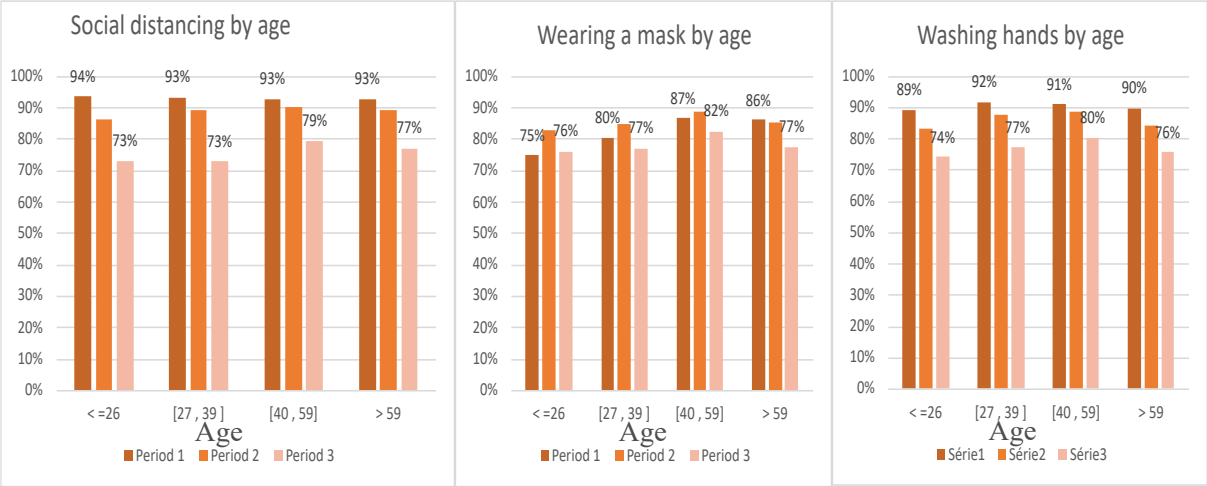
Except for the measure "wear a mask" in the first period, the age has no significant effect on the use of the safety measures (see Table 3).

Table 3: The obtained p−values between the age and each safety measure using Chi−square test in Algeria

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Period 1	0.980	0.000	0.631
Period 2	0.482	0.149	0.115
Period 3	0.101	0.157	0.252

Concerning the first period and the measure "wear a mask", one can see that greater is the age, greater is the percentage of people wearing a mask (see Figure 4).

Figure 4: Safety measures by age in Algeria



Source: Computed by the authors using CAPI-CREAD survey data

- Educational level Analysis

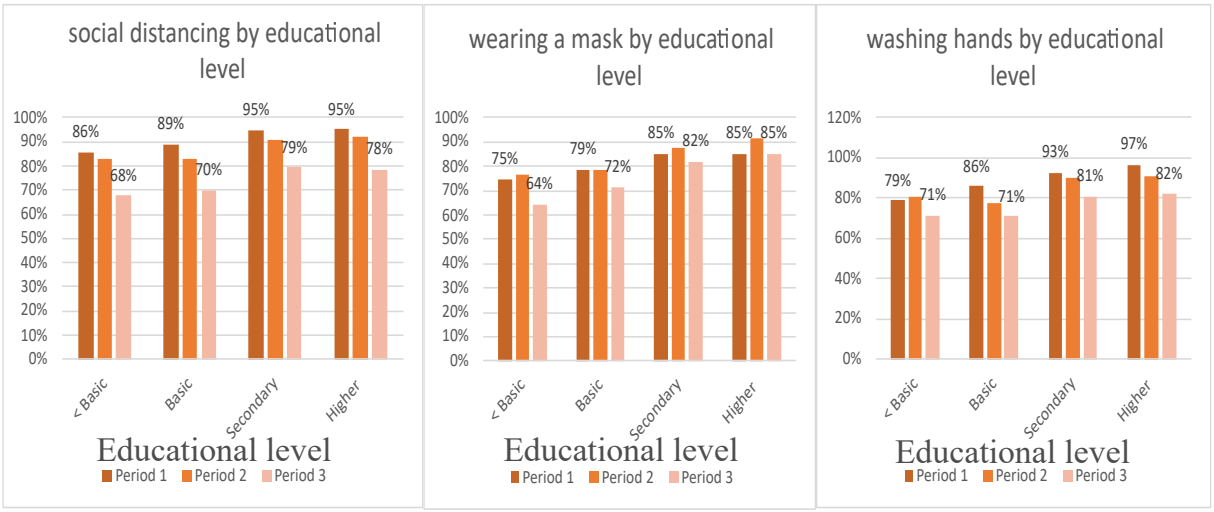
The obtained results using Chi-square tests show that the educational level has a significant effect on the use of all safety measures, and for each period (see Table 4).

Table 4: The obtained p−values between the educational level and each safety measure using Chi−square test in Algeria

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Period 1	0.001	0.024	0.000
Period 2	0.003	0.000	0.000
Period 3	0.010	0.000	0.000

Furthermore, it is shown that more is the educational level, more is the percentage of respectful people, whatever the measure and whatever the period (see Figure 5).Concerning the most used safety measures, we notice that they differs from a period to another following the educational level.

Figure 5: Safety measures by educational level in Algeria



Source: Computed by the authors using CAPI-CREAD survey data

- Residence region Analysis

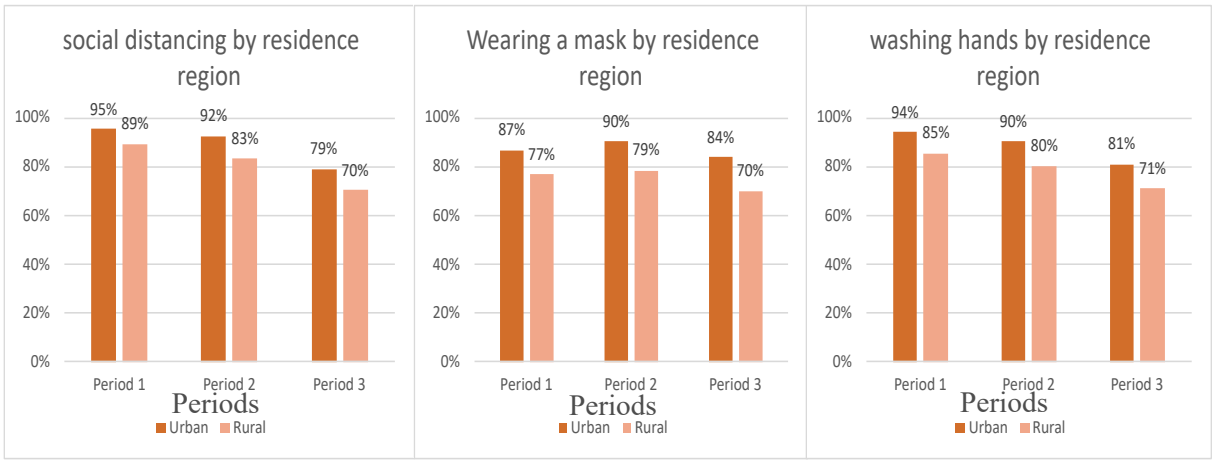
The residence region has also a significant effect on the use of the safety measures (see Table 5).

Table 5: The obtained p−values between the residence region and each safety measure using Chi−square test in Algeria

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Period 1	0.000	0.000	0.000
Period 2	0.000	0.000	0.000
Period 3	0.000	0.000	0.000

In this regard, urban people are more respectful than rural people, whatever the measure, and whatever the period (see Figure 6).

Figure 6: Safety measures by residence region in Algeria

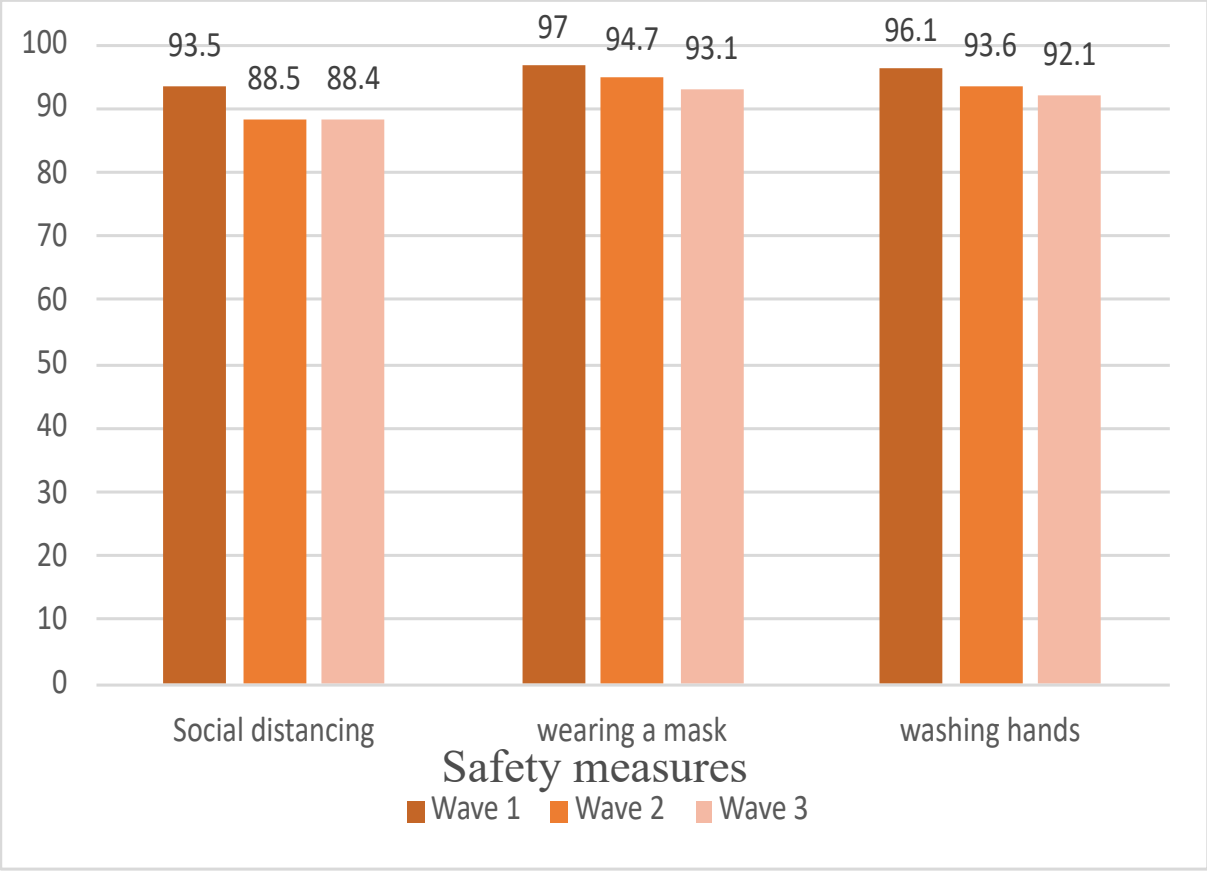


Source: Computed by the authors using CAPI-CREAD survey data

2.1.2. Morocco

The safety measures are, in general, well observed in Morocco. Indeed, the percentage of people wearing a mask varies between 97% and 93.1% over the time, making of the measure "wear a mask" the most used one in Morocco. The second measure to be mostly used is the "washing hands" with a percentage of people varying between 96.1% and 92.1%. The social distancing is however less observed with percentage of people varying between 93.5% and 88.4% (see Figure 7). Despite the decreasing percentages of people observing the safety measures over the time, this reduction is somehow important only for the measure "social distancing" where the percentage of people abandoning it in the second wave reached 5% points; otherwise the reductions are about 1% point to 2% points.

Figure 7: Moroccans and safety measures



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

- Gender analysis

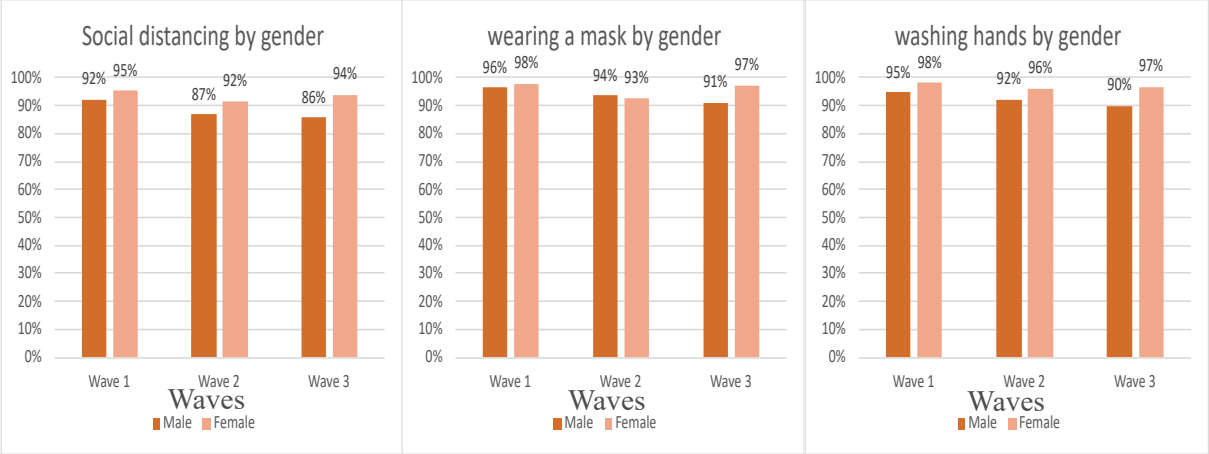
The used safety measures in Morocco significantly depend on the gender, in all waves and for all safety measures (see Table 6). In this regard, women are more respectful than men (see Figure 8).

Table 6: The obtained p−values between the gender and each safety measure using Chi−square test in Morocco

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.004	0.022	0.000
Wave 2	0.001	0.003	0.000
Wave 3	0.000	0.000	0.000

Two major differences are noticeable between men and women. The first one concerns, the trends of the used safety measures over time. Indeed, the percentage of men observing each safety measure decreases within time; whereas the percentage of women decreases in the second wave compared to the first one, then it increases in the third wave compared to the second one. The second difference is about the most used safety measure. In this direction, the most used safety measure by women in the first and the second waves is "washing hands" with 98% respectively 96.3%. In the third wave, women mostly use the measure "wear a mask" with 97.2%. However, men mostly use the measure "wear a mask" all over the time (see Figure 8).

Figure 8: Safety measures by gender in Morocco



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

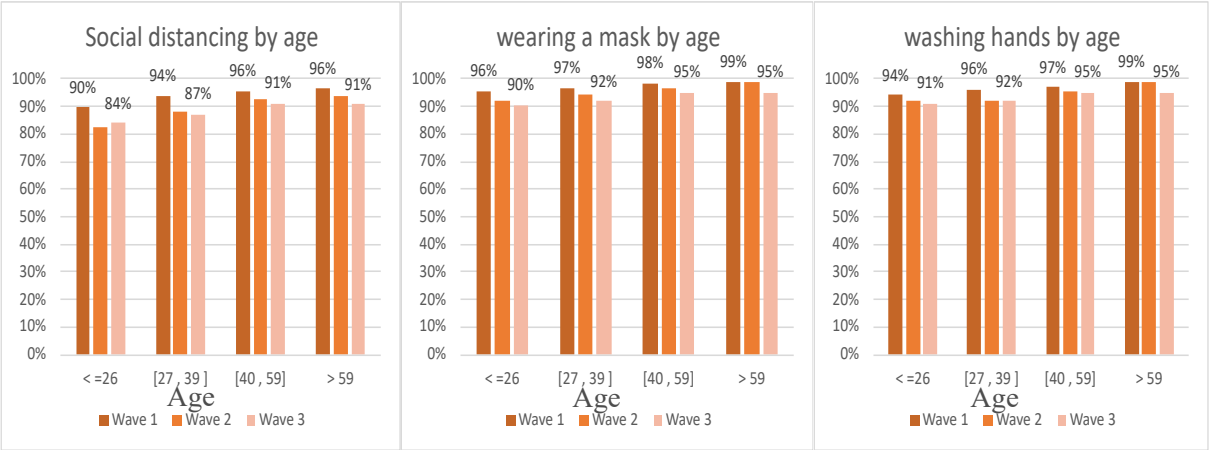
- Age analysis

The age is also a significant parameter influencing the use of the safety measures, whatever the wave (see Table 7). In this regards, the percentages of people observing the safety measure increase when the age is increasing (see Figure 9). For all age categories, the measure "social distancing" is less observed than the others.

Table 7: The obtained p−values between the age and each safety measure using Chi−square test in Morocco

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.000	0.023	0.026
Wave 2	0.000	0.003	0.002
Wave 3	0.002	0.008	0.008

Figure 9: Safety measures by age in Morocco



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

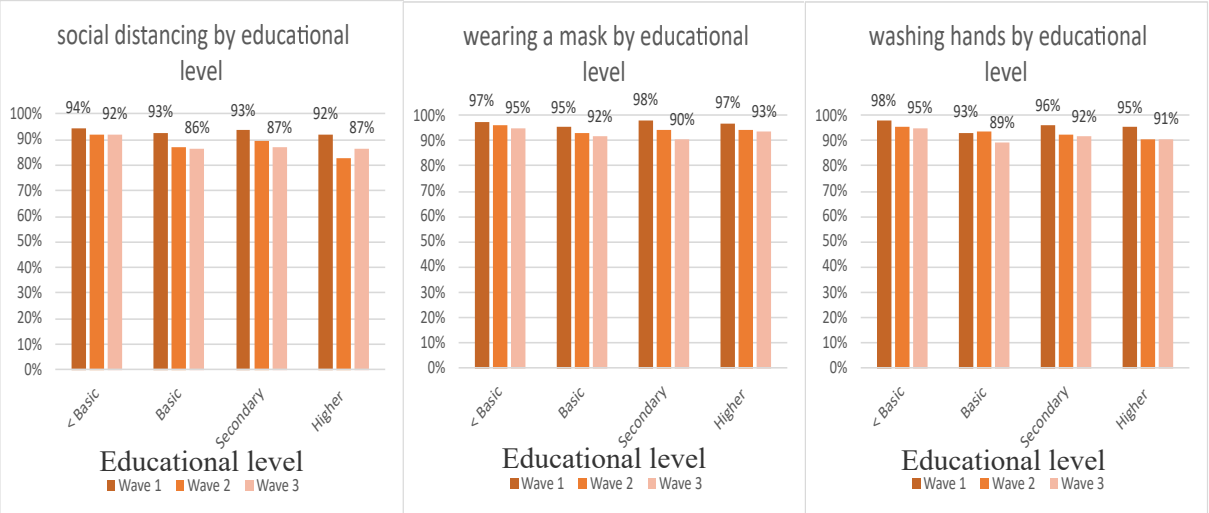
- Educational level analysis

The effect of the educational level on Moroccans behavior differs following the safety measure kind and the period of time, however it has a significant effect on the measure " wash hands" all over the time (see Table 8). In general, people with less than basic level are those who mostly observe the safety measures (see Figure 10).

Table 8: The obtained p−values between the educational level and each safety measure using Chi−square test in Morocco

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.380	0.180	0.001
Wave 2	0.000	0.084	0.005
Wave 3	0.003	0.025	0.001

Figure 10: Safety measures by educational level in Morocco



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

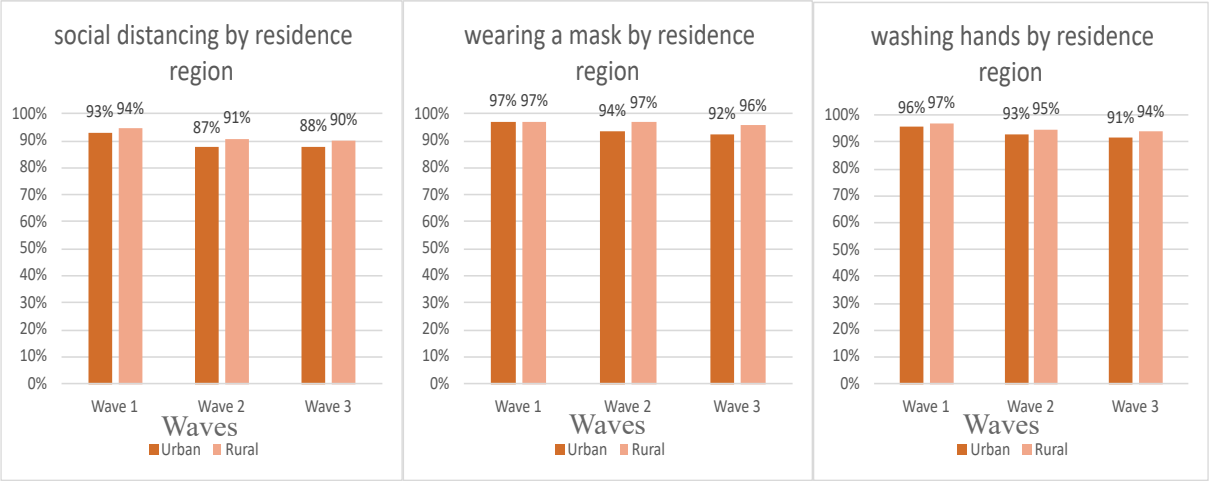
- Residence region analysis

As the educational level, the effect of the residence region on Moroccans' behavior changes following the safety measure kind, and the period of time (see Table 9). In general, the rural people are those who mostly observe the safety measures (see Figure 11). However, for the urban people as for rural ones the most used safety measure is "wear a mask", whatever the wave.

Table 9: The obtained p−values between the residence region and each safety measure using Chi−square test in Morocco

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.140	0.515	0.049
Wave 2	0.016	0.002	0.074
Wave 3	0.093	0.004	0.040

Figure 11: Safety measures by residence region in Morocco

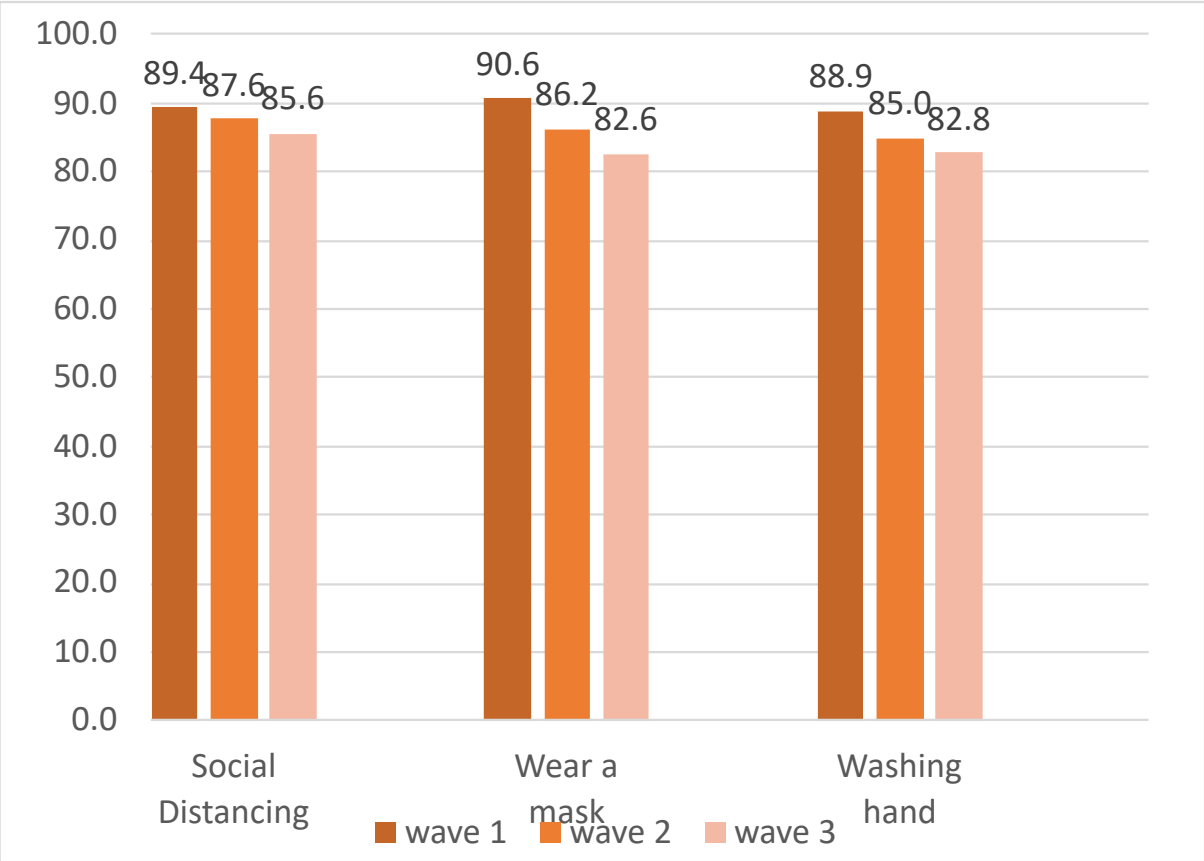


Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

2.1.3. Tunisia

With 90.6% of Tunisians stating that they wear a mask when outside home, this measure is the most observed one in the first wave; followed by the social distancing (89.4%) and the wash of hands (88.9%). However, one can notice that these measures were less observed when time goes on. Indeed, a decrease of 4.4% points, respectively 1.8% points and 3.9% points, of people wearing a mask, respectively observing a social distancing and hands washing, is noticed when moving from the first to the second wave. This decrease also happens from the second to the third wave; where only 82.6% observe the measure "wearing a mask", becoming the less observed measure just behind the hands washing (82.8%) and the social distancing (85.6%). The ranking of theses measures by the percentage of people observing them is then completely reversed from the first to the third wave (see Figure 12).

Figure 12: Tunisian and safety measures (%)



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

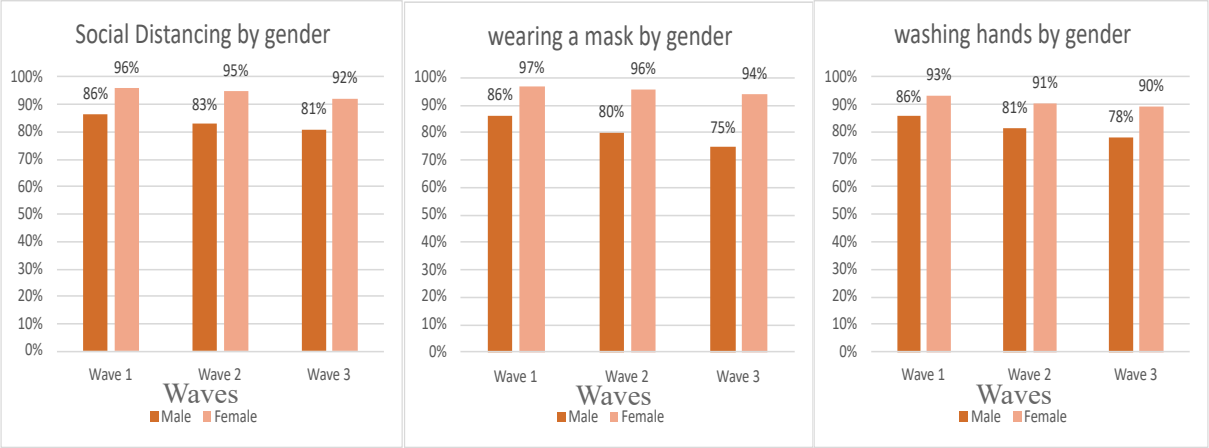
- Gender analysis

The obtained results using Chi−square tests show that the gender has a significant effect on Tunisians' safety measures use, in each period of time (wave) (see Table 10). Furthermore, women are more respectful than men. Indeed, the percentage of women observing each safety measure is greater than the percentage of men doing it (see Figure 13).

Table 10: The obtained p−values between the gender and each safety measure using Chi−square test in Tunisia

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.000	0.000	0.000
Wave 2	0.000	0.000	0.000
Wave 3	0.000	0.000	0.000

Figure 13: Safety measure by gender in Tunisia



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

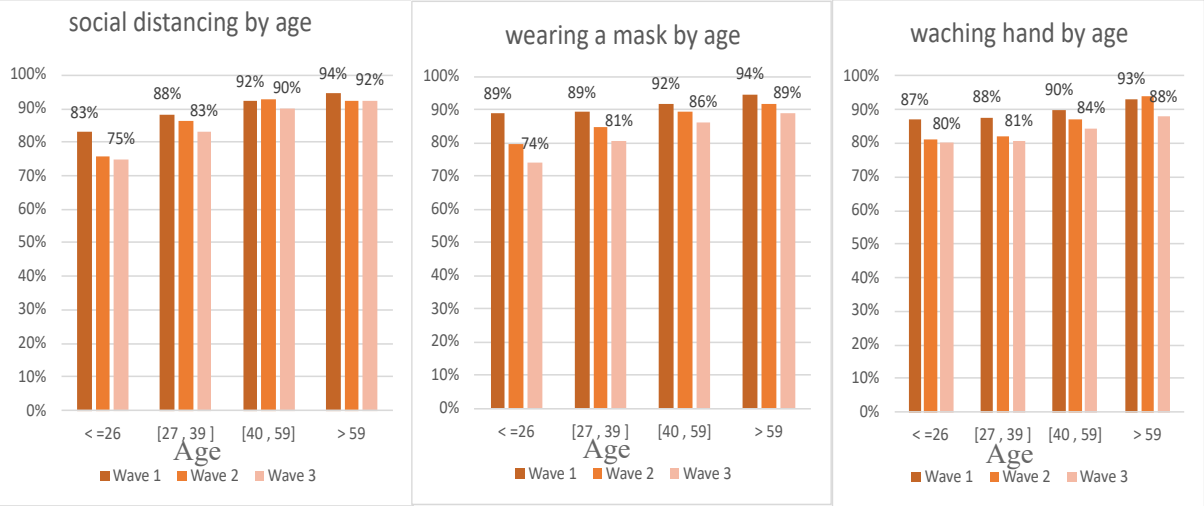
- Age analysis

Except for the measure "wash hands" and "wear a mask" in the first period of time, the age has a significant effect on the Tunisians' use of safety measures (see Table 11). In this regards, one can see that more is the age more is the safety measures respect (see Figure 14). Also, the percentage of people observing each measure decreases over the time, except for the last age category (> 59 years) regarding the "washing hands" measure. In fact, one can remark that the percentage of the elderly observing this measure increases slightly ($+0.96$% point) from the first to the second wave, then it decreases by 6.15% points from the second to the third wave.

Table 11: The obtained p−values between the age and each safety measure using Chi−square test in Tunisia

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.000	0.089	0.132
Wave 2	0.000	0.000	0.000
Wave 3	0.000	0.000	0.037

Figure 14: Safety measure by age in Tunisia



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

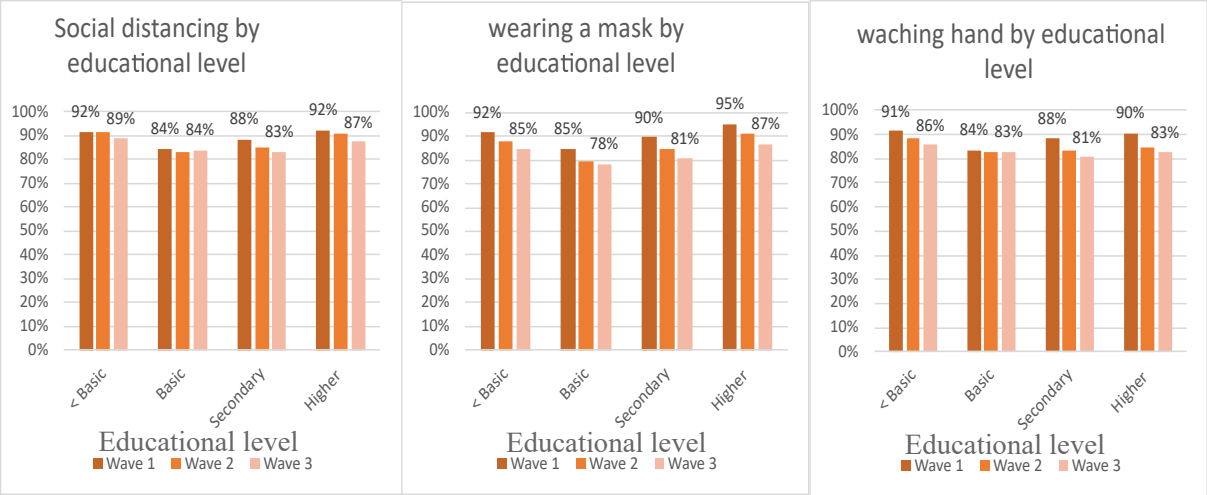
- Educational level analysis

Except for the measure "wash hands" in the third period of time, the educational level has a significant effect on the Tunisians' use of the safety measures (see Table 12). In this regard, people with educational level less than basic and those having higher educational lever, are the most respectful toward the use of safety measures (see Figure 15).

Table 12: The obtained p−values between the educational level and each safety measure using Chi−square test in Tunisia

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.001	0.000	0.006
Wave 2	0.000	0.000	0.036
Wave 3	0.028	0.003	0.112

Figure 15: Safety measure by educational level in Tunisia



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

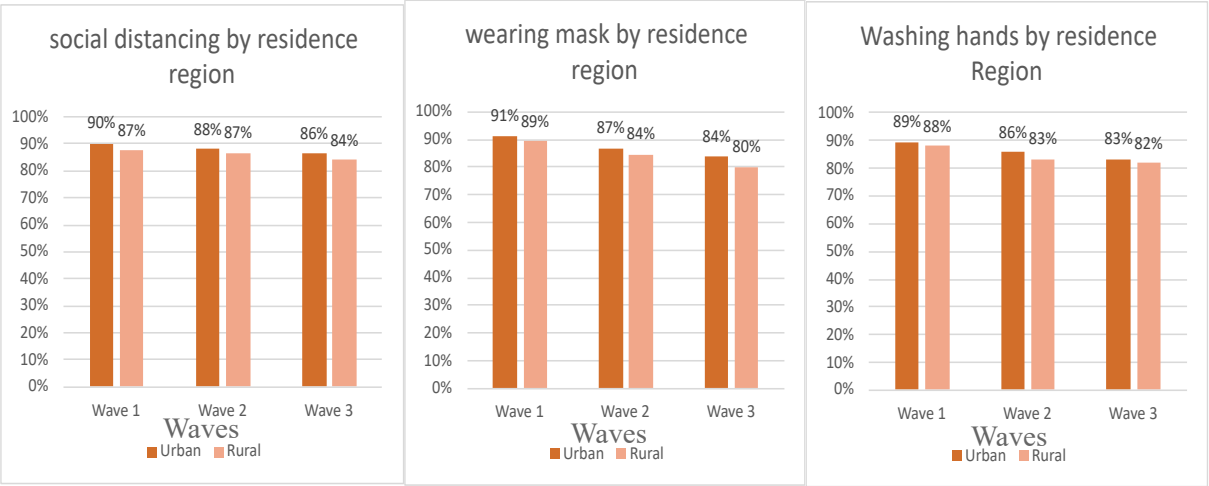
- Residence region analysis

According to Chi−square results, one can see that the residence region effects on the Tunisians' behavior differ from a safety measure to another, and from a period of time to another (see Table 13). But in general, urban people are more respectful than rural people. Moreover, for both of them the most observed measure is "wearing a mask" (see Figure 16).

Table 13: The obtained p−values between the residence region and each safety measure using Chi−square test in Tunisia

	Social Distancing (Y_1)	Wear a mask (Y_2)	Wash Hands (Y_3)
Wave 1	0.043	0.109	0.221
Wave 2	0.236	0.077	0.101
Wave 3	0.099	0.023	0.228

Figure 16: Safety measure by residence region in Tunisia



Source: Computed by the authors using ERF Covid-19 MENA Monitor survey data

2.1.4. Countries comparison

Before comparing the results of the three countries, it is important to highlight that the three data waves of both Morocco and Tunisia are embedded in the third data period of Algeria. Therefor, the comparisons will only take into account the evolution of these populations' behavior over time, without comparing what happens in each country, in the same period of time (see Figure 1).

When comparing among the three countries, it appears that Moroccans are more respectful toward each safety measure compared to Algerians or Tunisians. We also notice a common decrease in the percentage of people observing each safety measure all over the time, except for Algerian people in the second period, where we notice an increase of 2.9% of people wearing a mask. Moreover, the diminutions rates are more important in Algeria compared to Morocco or Tunisia. This could be explained by the studied periods of time, which are longer, and cover 15 months in Algeria. Comparing between Morocco and Tunisia, these diminutions rates are, in general, higher in Tunisia. In fact, the only case where the Moroccan diminution rate is higher than the Tunisian one concerns social distancing, from November, 2020 to February, 2021 (see Table 14).

Table 14: Comparative table among the different countries

		Algeria	Morocco	Tunisia
Social distancing	N_1	93%	93.5%	89.4%
	Δ_1	-4.4%	-5%	-1.8%
	Δ_2	-13.1%	-0.1%	-2%
Wearing a mask	N_1	82.7%	97%	90.6%
	Δ_1	$+2.9\%$	-2.3%	-4.4%
	Δ_2	-7.2%	-1.6%	-3.6%
Washing hands	N_1	90.7%	96.1%	88.9%
	Δ_1	-4.5%	-2.5%	-3.9%
	Δ_2	-9.4%	-1.5%	-2.2%

Focusing on the basic social variables: gender, age, educational level and residence region, and their effects on the populations' behavior toward each safety measure, it appears that:

(i) Their effects on the populations' behavior differ following: the country, the safety measure kind, and the period of time. In this regard, the variables which have a significant effect, whatever the safety measure kind, and over the three periods of time are: residence region and educational level in Algeria; Gender and age in Morocco, and only gender in Tunisia.

(ii) There is no common trend among the three countries in term of most used safety measure, whatever the variable (see Table 15).

(iii) Even in the same country, the most used safety measure is not generally the same all over the time, whatever the variable (see Table 15). However, in each country, one exception (i.e. the same safety measure is mostly used all over the time) is noticed:

- Urban people mostly use social distancing in Algeria.
- Men mostly use the measure "wear a mask" in Morocco.
- Men mostly use social distancing, whereas women mostly use the measure " wear a mask" in Tunisia.

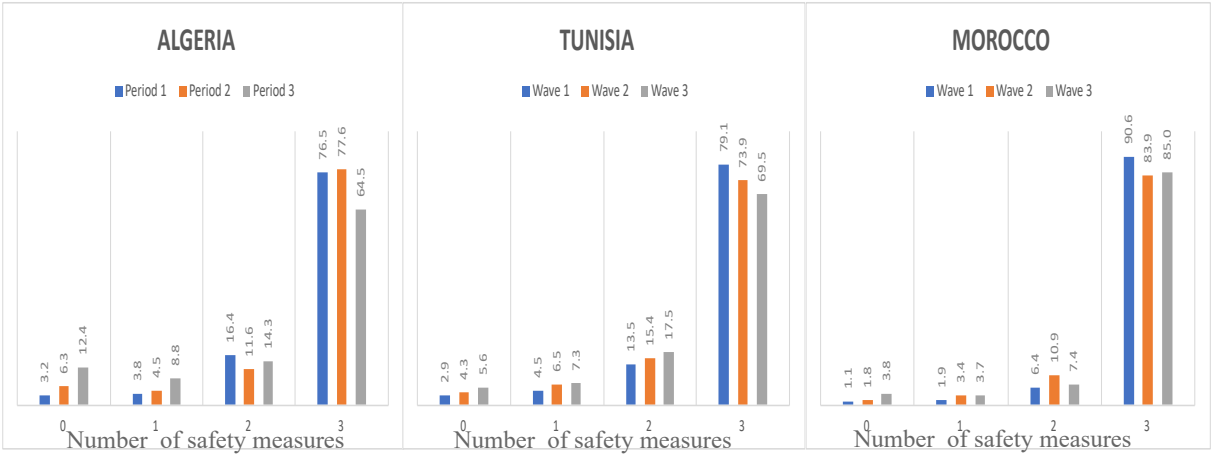
Table 15: Most used safety measure within the basic social variables (z_j) in each country. SD: Social distancing, WM: wear a mask and WH: washing hands. For each variable z_j, the given p−values corresponds to the maximum p−value among all safety measures (i.e. variables $Y_i,\ \forall i = \overline{1,3}$)

		Wave 1			Wave 2			Wave 3		
		Algeria	Morocco	Tunisia	Algeria	Morocco	Tunisia	Algeria	Morocco	Tunisia
Gender	p−value	$>$ **0.05**	0.04	0.000	$>$ **0.05**	0.003	0.000	0.04	0.000	0.000
	Women	SD	WH	WM	SD	WH	WM	WM	WM	WM
	Men	SD	WM	SD	SD	WM	SD	WH	WM	SD
Age	p−value	$>$ **0.05**	$>$ **0.05**	$>$ **0.05**	$>$ **0.05**	0.01	$>$ **0.05**	$>$ **0.05**	$>$ **0.05**	$>$ **0.05**
	$<= 26$ years	SD	WM	WM	SD	WM	WH	WM	WH	WH
	$[27; 39]$	SD	WM	WM	SD	WM	SD	WH	WM	SD
	$[40; 59]$	SD	WM	SD	SD	WM	SD	WM	WM	SD
.	> 59 years	SD	WM/WH	SD/WM	SD	WM/WH	WH	WM	WM	SD
Residence region	p−value	0.000	$>$ **0.05**	$>$ **0.05**	0.000	$>$ **0.05**	$>$ **0.05**	0.000	$>$ **0.05**	$>$ **0.05**
	Urban	SD	WM	WM	SD	WM	SD	SD	WM	SD
	Rural	SD	WH	WM	SD	WM	SD	WH	WM	SD
Educational level	p−value	0.024	$>$ **0.05**	0.006	0.003	$>$ **0.05**	0.036	0.010	0.025	$>$ **0.05**
	less than basic	SD	WH	SD/WM	SD	WM	SD	WH	WH	SD
	Basic	WH	WM	WM	SD	WH	SD	WM	WM	SD
	Secondary	SD	WM	WM	SD	WM	SD	WM	WM	SD
	Higher	WH	WM	WM	SD	WM	WM	WM	WM	SD

2.2. Number of observed safety measures

When analyzing the safety measures number, it appears that each country has its own trend over the time; however, most people observe three safety measures all over the time and for all countries. Moreover, the highest percentage of people observing three safety measures is reached in Morocco (see Figure 17).

Figure 17: Percentage of people observing safety measures number



Source: Computed by the authors using both ERF Covid-19 MENA Monitor and CAPI−CREAD surveys data

In Algeria, the percentage of people who respect three safety measures reaches its highest score (77.6%) in the second period, whereas the percentage of people who respects two safety measures reaches its minimum (11.6%) in this same period. Moreover, the percentage of people who respect no safety measure or respects at most one measure increases over time. From the second to the third period, the percentage of people observing three safety measures decreases by 13.1% whereas the percentage of people observing no measure respectively 1 or 2 increases by 6.1% respectively 4.3% and 2.7%. This underlines the fact that, among people who changed their behavior over time, most of them abandoned the safety measures.

In Morocco, the percentage of people who respect three safety measures stays high over time ($\geq 85\%$). In the second wave, this percentage decreased by 6.7% points. However, among people who decreased this number 67% deleted one measure, and only 10% abandoned all measures. In the third wave, the percentage of people who respects two safety measures decreased by 3.5% points. Among these people 31% increased the number of used safety measures to adopt three measures, and 57% abandoned all these measures.

In Tunisia, the percentage of people observing three measures decreases over the time, whereas the percentage of people observing 0, 1 or 2 measures is increasing. This results shows that Tunisians progressively reduce the number of measures that they observe.

Transition graphs

When analysing the transition graphs (Figures 18−23), we notice three major remarks:

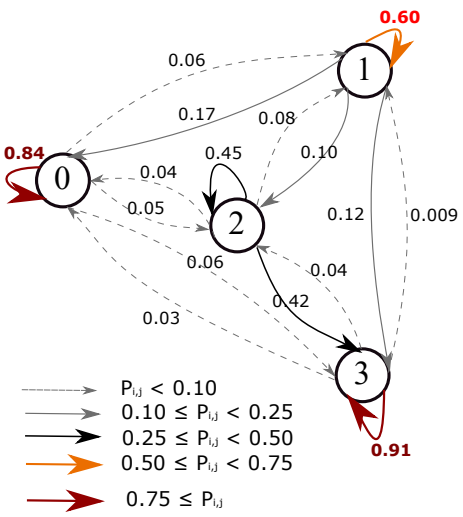
1. In all countries, the transition probabilities from the first to the second wave/period are different from the transition probabilities from the second to the third wave/period. In other words, the passing dynamic from a state (a given number of used safety measures) to another in the first transition (from the first to the second wave/period) is not the same as that one in the second transition (from the second to the third wave/period).

2. The transition probabilities from zero (no measure) to zero (no measure) increase over time in all countries. That is, the probability that a person who observes no safety measure continues to do so increases within time, whatever the country.

3. The transition probabilities from 3 (three measures) to 3 (three measures) are greater than 0.8 in all countries. In other words, more than 80% of people observing the three safety measures continue to do so within time, whatever the country. However, over time these probabilities are decreasing for both Algeria and Tunisia, whereas they remain constant for Morocco.

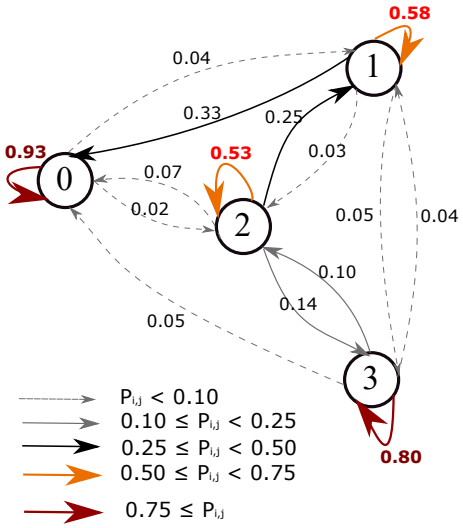
Algerians mostly keep the same behavior over both transitions i.e most people observing a number v_i of safety measures at the first period, continues to observe the same number of safety measures at the second period. This observation stays true even for the transition from the second to the third period. In fact,the highest transition probabilities are those from a state v_i to v_i (see Figures 18 and 19). When comparing the second to the first graph, one can see that the transition probabilities from the states v_i to $v_{(i-1)}$ (such as: 1 to 0, 2 to 1, or 3 to 2) have increased, whereas the transitions from the states v_i to $v_{(i+1)}$ (such as: 0 to 1, 1 to 2, 2 to 3) have decreased. We also notice that there is no possible transition from the state 0 to 3.

Figure 18: Transition graph in Algeria from the first to the second period



Source: Computed by the authors

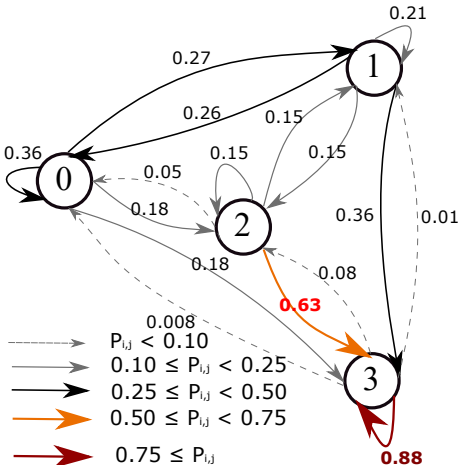
Figure 19: Transition graph in Algeria from the second to the third period



Source: Computed by the authors

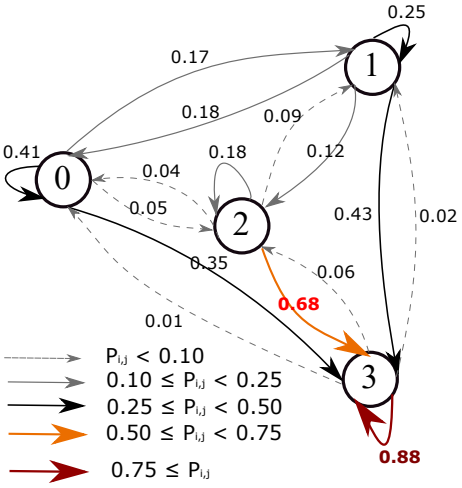
In Morocco, the first transition graph (Figure 20) shows a high transition probabilities from the state v_2 (two safety measures) to v_3 (three safety measures) and from three safety measures (v_3) to three safety measures (v_3). In the second graph (Figure 21), we see that all the transition probabilities from any state to the state v_3 have increased i.e. The probability to adopt 3 safety measures in the third wave for a person who observed 0, 1, or 2 safety measures in the second wave, increases.

Figure 20: Transition graph in Morocco from the first to the second wave



Source: Computed by the authors

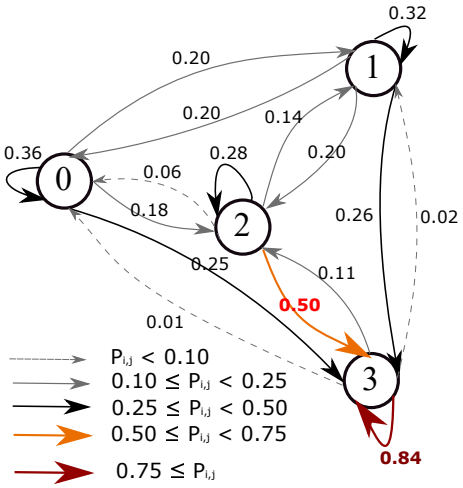
Figure 21: Transition graph in Morocco from the second to the third wave



Source: Computed by the authors

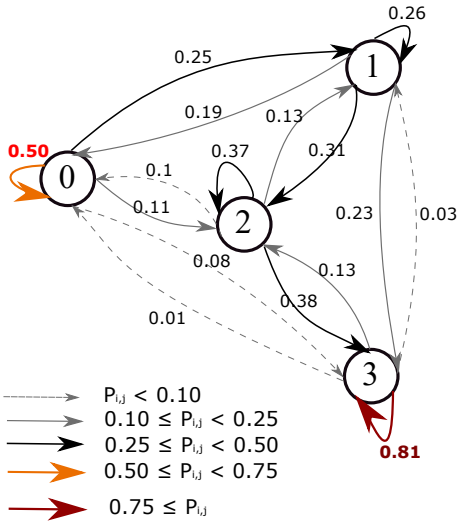
In Tunisia, the first graph (Figure 22) shows important transition probabilities from any state to the state v_3. Furthermore, more than one person over two observes three safety measures in the second wave against two measures in the first wave. In the second graph (Figure 23), the transition from 0 (no safety measure) to 3 safety measures has decreased, whereas the transitions probabilities from 0 (no measure) to 0 (no measure), 0 (no measure) to 1 measure, 1 measure to 2 measures and 2 measures to 2 measures have increased.

Figure 22: Transition graph in Tunisia from the first to the second wave



Source: Computed by the authors

Figure 23: Transition graph in Tunisia from the second to the third wave



Source: Computed by the authors

Simulations results

As the transition probabilities from the first to the second wave/period are different from those from the second to the third wave/period, we simulate for each country, the behavior of its populations following both graphs G^1 and G^2 separately. That is to say, we will reproduce the behavior of these populations following their passing dynamics, in terms of used safety measures' number, from the first to the second wave/period, then from the second to the third wave/period. This allows us to see what will happen if these behaviors are repeated over time. The main objective of these simulations is then to see how the populations' behavior evolves after several iterations, following the obtained transition probabilities. The obtained results show that:

(i) In Morocco, the percentage of people observing 0 respectively, 1, 2, and 3 safety measures converge to 5% respectively, 5%, 10% and 80%, even with different initial transition probabilities (Figure 26 and 27).

(ii) In Algeria as in Tunisia, the shape of the curves following both transition graphs G^1 and G^2 are the same, but at different scales. In the Algerian case the scale's difference is very large (Figure 24 and 25), whereas this difference is slight in the Tunisian case (Figure 28 and 29).

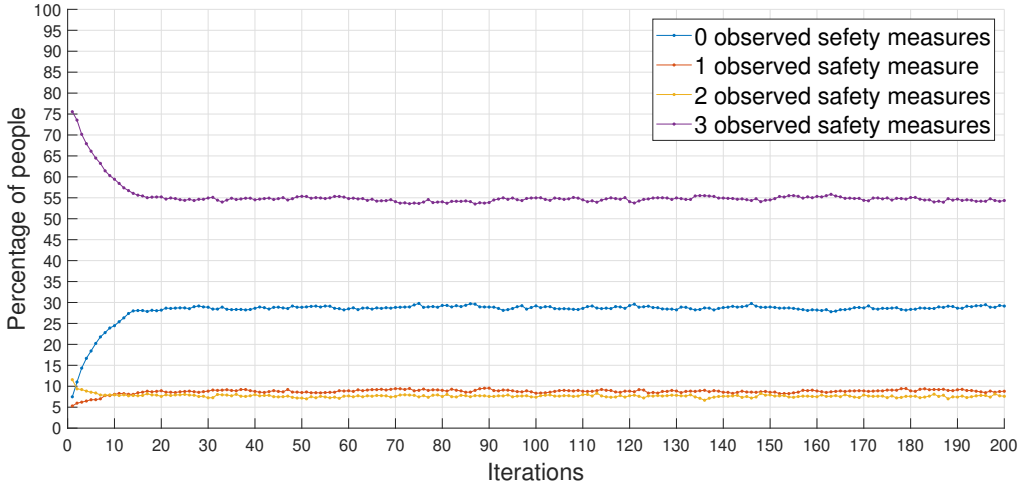
Using the transition probabilities of the graph G^1 in Algeria, we obtain (Figure 24):

- The percentage of people observing 3 safety measures decreases until the 20^{th} iteration, then converges to 55%.
- The percentage of people observing 0 safety measure increases until the 15^{th} iteration, then converges to 30%.
- The percentage of people observing 1 respectively 2 safety measures, converges to 8% respectively 7%.

However, the use of the transition probabilities of the graph G^2 shows that the percentage of people who will observe no safety measure over time will increase to $\simeq 82$%, whereas the percentage of people observing three safety measures will decrease to $\simeq 5$%. The percentage of people observing one respectively two safety measures will be about 10% respectively 3% (Figure 25).

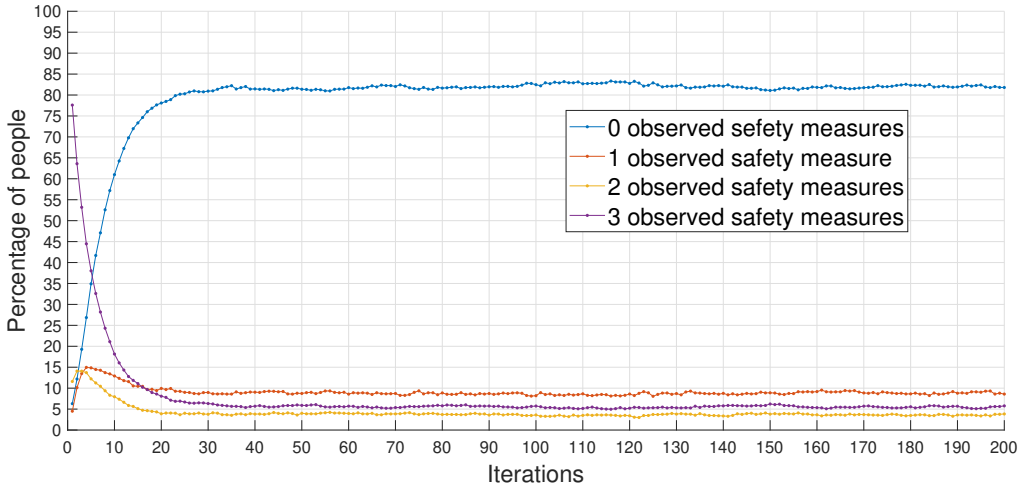
In Tunisian case, the transition probabilities of the graph G^1 show a decrease in the percentage of people observing three safety measures to $\simeq 70$% and a convergence of the percentage of people observing 2, respectively 1 and 0 to $\simeq 15$%, respectively $\simeq 9$% and $\simeq 6$% (Figure 28). following the second graph G^2, the percentage of people observing three safety measures converges to $\simeq 59$% when the percentage of people observing two safety measures, respectively 1 and 0 converges to $\simeq 19$%, respectively $\simeq 7$% and $\simeq 15$%.

Figure 24: Simulation of the percentage of people observing safety measures in terms of number in Algeria following the first transition graph(population size=10000)



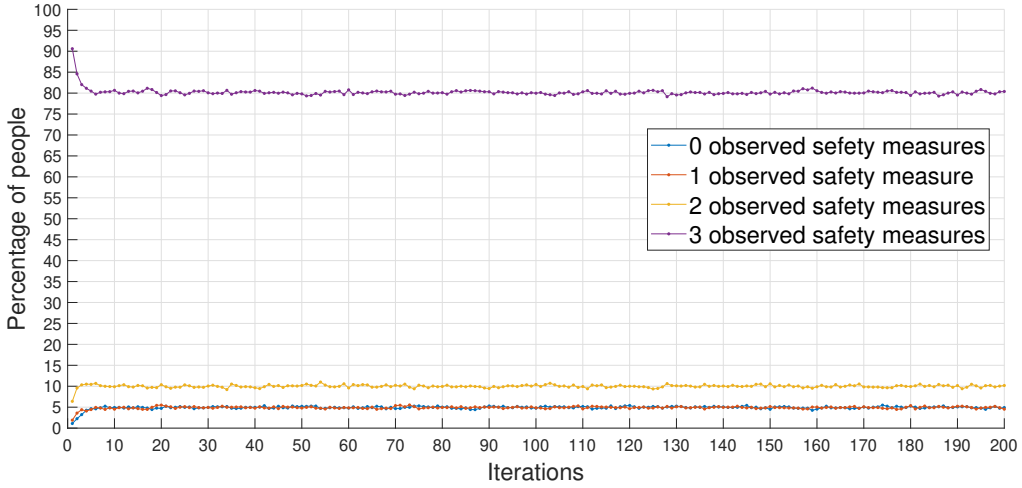
Source: Computed by the authors

Figure 25: Simulation of the percentage of people observing safety measures in terms of number in Algeria following the second transition graph(population size=10000)



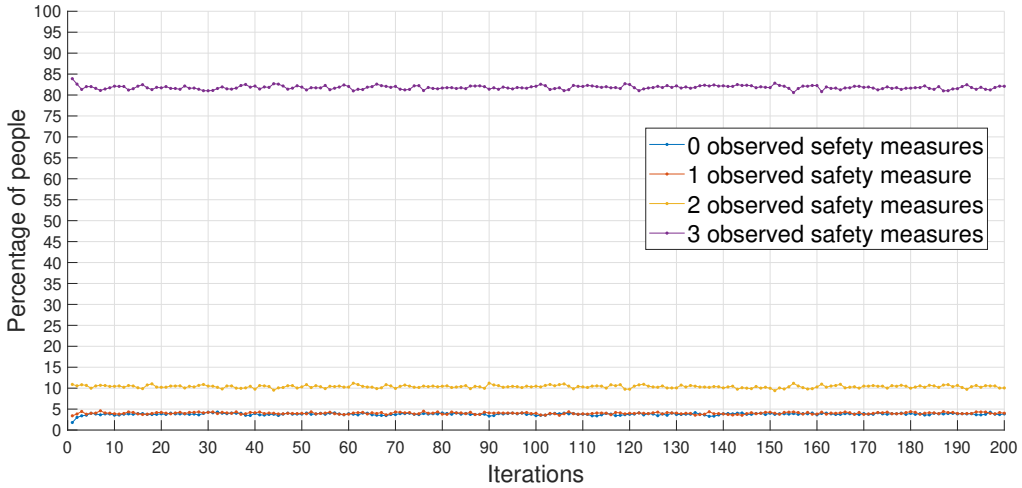
Source: Computed by the authors

Figure 26: Simulation of the percentage of people observing safety measures in terms of number in Morocco following the first transition graph(population size=10000)



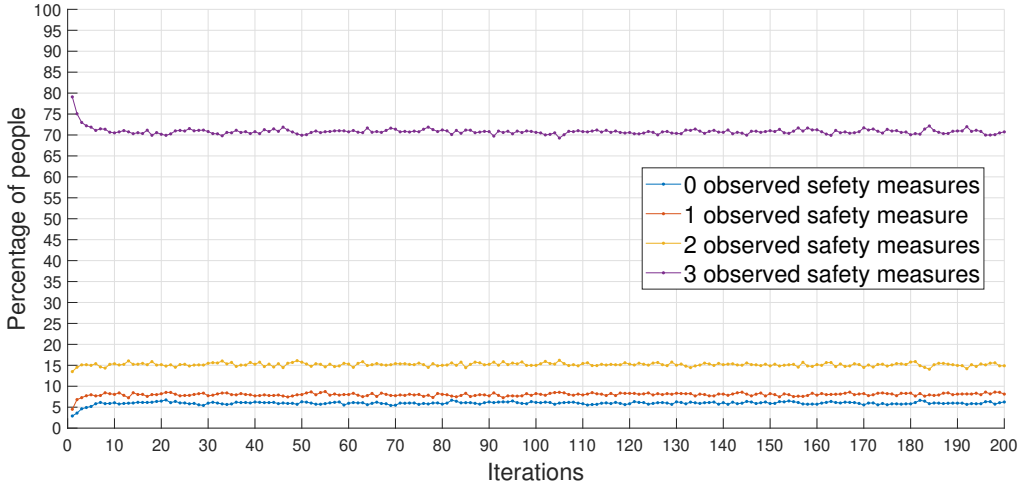
Source: Computed by the authors

Figure 27: Simulation of the percentage of people observing safety measures in terms of number in Morocco following the second transition graph(population size=10000)



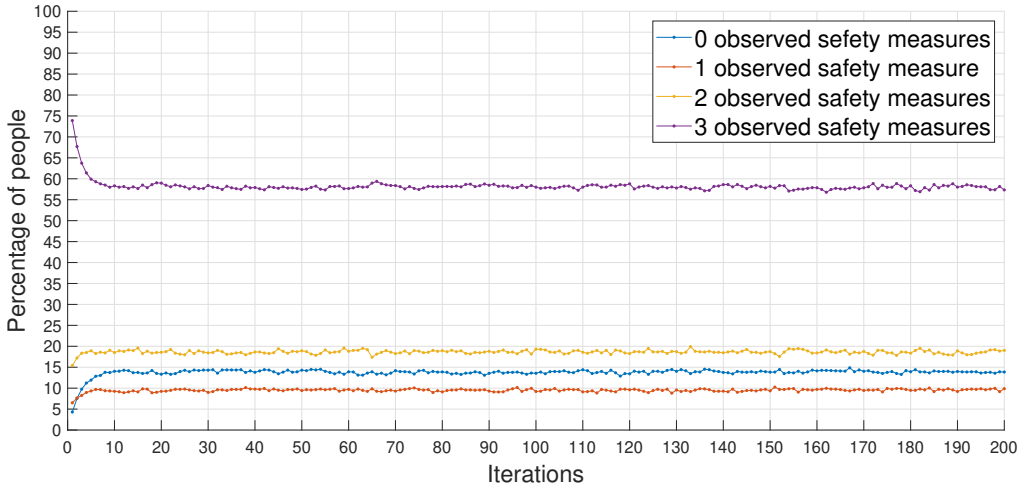
Source: Computed by the authors

Figure 28: Simulation of the percentage of people observing safety measures in terms of number in Tunisia following the first transition graph(population size=10000)



Source: Computed by the authors

Figure 29: Simulation of the percentage of people observing safety measures in terms of number in Tunisia following the second transition graph(population size=10000)



Source: Computed by the authors

Determinants of observed safety measures

The used logit model allows us the obtention of the results summarized in Tables 16 – 17.

Table 16: Determinants of observed safety measures - marginal effects

	Morocco		Tunisia	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Socio-demographic characteristics				
Sex (ref: Women)	-0.0178***	-0.0248***	-0.0133***	-0.0363***
Men	(0.00276)	(0.00318)	(0.00272)	(0.00371)
Marital status (ref: Ever Married)	0.00154	0.00128	-0.00564**	-0.0137***
Never married	(0.00283)	(0.00345)	(0.00252)	(0.00476)
Age (ref:18-24 years)				
25-34 years	0.00374	0.00343	0.000825	-0.00179
	(0.00298)	(0.00366)	(0.00185)	(0.00379)
35-54 years	0.00926**	0.00921**	0.00603**	0.00732
	(0.00363)	(0.00434)	(0.00252)	(0.00446)
55-64 years	0.0118***	0.0132***	0.0115***	0.0198***
	(0.00266)	(0.00338)	(0.00236)	(0.00354)
Stratum (ref : rural)				
Urban	-0.00761***	-0.00990***	0.00346**	0.00581*
	(0.00234)	(0.00277)	(0.00170)	(0.00303)
Camp	---	---	---	---
Educational Attainment (ref: Less than basic)				
Basic	-0.00761*	-0.00798*	-0.00706**	-0.0157**
	(0.00399)	(0.00463)	(0.00337)	(0.00628)
Secondary	-0.000588	-0.000132	-0.00477*	-0.0100**
	(0.00346)	(0.00412)	(0.00245)	(0.00454)
Higher education	-0.00588	-0.00650	-0.000349	0.00216
	(0.00371)	(0.00437)	(0.00266)	(0.00476)
Household characteristics				
Household size	-0.00123*	-0.00143	-0.000644	-0.00139
	(0.000744)	(0.000886)	(0.000911)	(0.00162)
Household size square	2.20e-05	2.34e-05	5.08e-05	8.49e-05
	(2.59e-05)	(2.89e-05)	(6.40e-05)	(0.000107)
Number of children under age six in the household	0.00113	0.000903	-0.00158*	-0.00257*
	(0.00135)	(0.00165)	(0.000815)	(0.00148)
Number of children enrolled in school	-0.000486	-0.000437	0.000421	0.00187
	(0.000948)	(0.00116)	(0.000635)	(0.00121)
Labor market situation				
(ref: Non-wage)				
Formal	0.00724***	0.00921***	0.00603***	0.0135***
	(0.00239)	(0.00282)	(0.00182)	(0.00299)
Informal	-0.000150	0.000100	0.000627	0.00184
	(0.00323)	(0.00384)	(0.00182)	(0.00337)
Unemployed	0.00790***	0.00957***	-0.000696	-0.00206
	(0.00240)	(0.00288)	(0.00195)	(0.00377)
Out of labor force	0.00288	0.00315	-0.00165	-0.00270
	(0.00298)	(0.00364)	(0.00270)	(0.00507)
Worried about being infected with COVID-19 (ref: Very Worried)				
Not at all| worried	-0.0241***	---	-0.0343***	---
	(0.00493)		(0.00775)	
A little worried	0.00279	---	-0.00220	---
	(0.00421)		(0.00383)	
Rather worried	-0.00535	---	0.0143***	---
	(0.00844)		(0.00249)	
Wave (ref:Wave1)				
Wave 2	-0.00425	-0.00841	-0.00521**	-0.00995**
	(0.00491)	(0.00636)	(0.00259)	(0.00472)
Wave 3	-0.0203***	-0.0311***	-0.0116***	-0.0206***
	(0.00642)	(0.00839)	(0.00345)	(0.00551)
Observations	**8120**	**8120**	**8143**	**8143**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 17: Determinants of observed safety measures - Wave interaction (odds ratio)

	Morocco		Tunisia	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Socio-demographic characteristics				
Sex (ref: Women)	0.305*	0.239**	0.518*	0.305***
Men	(0.195)	(0.152)	(0.190)	(0.111)
Wave # Sex (ref: wave 1 * women)				
Wave 2# Sex	0.639	0.667	0.368*	0.415
	(0.561)	(0.584)	(0.208)	(0.232)
Wave 3 # Sex	0.970	1.050	0.599	0.620
	(0.708)	(0.764)	(0.281)	(0.287)
Wave 4 # Sex	1.014	1.050	0.356*	0.370*
	(0.705)	(0.727)	(0.213)	(0.219)
Marital status (ref: Ever Married)	0.525	0.530	0.945	0.838
Never married	(0.255)	(0.254)	(0.292)	(0.254)
Wave # Marital status (ref: wave 1 * Ever Married)				
Wave 2 # Marital status	2.525	2.310	0.484*	0.507*
	(1.500)	(1.361)	(0.182)	(0.187)
Wave 3 # Marital status	2.175	1.995	0.652	0.691
	(1.160)	(1.051)	(0.230)	(0.239)
Wave 4 # Marital status	2.169	2.209	0.749	0.707
	(1.122)	(1.130)	(0.294)	(0.271)
Age (ref:18-24 years)				
25-34 years	1.278	1.204	1.085	0.926
	(0.264)	(0.245)	(0.188)	(0.154)
35-54 years	1.823**	1.639**	1.730***	1.394
	(0.436)	(0.385)	(0.364)	(0.285)
55-64 years	2.902***	2.568***	4.979***	3.730***
	(0.987)	(0.865)	(1.741)	(1.281)
Stratum (ref : rural)	0.371*	0.365*	1.570	1.594
	(0.216)	(0.211)	(0.458)	(0.454)
Wave # Urban (ref: wave 1 # rural)	0.631	0.630	0.982	0.884
	(0.503)	(0.501)	(0.376)	(0.328)
Wave 2 # Urban	1.326	1.268	1.047	0.948
	(0.885)	(0.841)	(0.380)	(0.334)
Wave 3 # Urban	2.629	2.550	0.446*	0.450**
	(1.664)	(1.603)	(0.186)	(0.182)
Educational Attainment (ref: Less than basic)				
Basic	0.449	0.464	0.499	0.421*
	(0.247)	(0.254)	(0.242)	(0.201)
Secondary	2.202	2.109	0.465*	0.477*
	(1.882)	(1.788)	(0.209)	(0.212)
Higher education	0.949	0.921	1.301	1.455
	(0.636)	(0.611)	(0.806)	(0.895)
Wave 2 # Basic	1.423	1.456	0.857	0.934
	(1.018)	(1.037)	(0.547)	(0.582)
Wave 2 # Secondary	0.580	0.558	1.061	0.979
	(0.586)	(0.561)	(0.635)	(0.576)
Wave 2 # Higher education	0.970	0.992	0.587	0.598
	(0.803)	(0.817)	(0.461)	(0.464)
Wave 3 # Basic	1.260	1.222	1.767	2.011
	(0.815)	(0.786)	(1.019)	(1.132)
Wave 3 # Secondary	0.306	0.326	1.993	1.869
	(0.284)	(0.300)	(1.058)	(0.977)
Wave 3 # Higher education	0.852	0.889	0.710	0.731
	(0.642)	(0.663)	(0.502)	(0.512)
Household characteristics				
Household size	0.925*	0.930	0.943	0.938
	(0.0434)	(0.0429)	(0.0773)	(0.0705)
Household size square	1.001	1.001	1.005	1.004
	(0.00164)	(0.00152)	(0.00577)	(0.00499)
Number of children under age six in the household	1.076	1.051	0.865**	0.890*
	(0.0924)	(0.0909)	(0.0605)	(0.0603)
Number of children enrolled in school	0.964	0.972	1.040	1.090
	(0.0585)	(0.0589)	(0.0591)	(0.0603)
Labor market situation				
(ref: Non-wage)				
Formal	1.714***	1.769***	1.898***	2.090***
	(0.357)	(0.364)	(0.368)	(0.397)
Informal	1.001	1.012	1.054	1.085
	(0.203)	(0.203)	(0.179)	(0.177)
Unemployed	1.796***	1.795***	0.925	0.904
	(0.369)	(0.366)	(0.157)	(0.149)
Out of labor force	1.195	1.173	0.877	0.890
	(0.242)	(0.237)	(0.194)	(0.192)
Worried about being infected with COVID-19 (ref: Very Worried)				
Not at all| worried	0.271***	---	0.126***	---
	(0.0612)		(0.0333)	
A little worried	1.206	---	0.831	---
	(0.348)		(0.262)	
Rather worried	0.758	---	10.86**	---
	(0.317)		(11.22)	
Wave (ref:Wave1)				
Wave 2	1.027	0.897	2.574	2.477
	(1.141)	(1.001)	(1.854)	(1.783)
Wave 3	0.231	0.189*	0.544	0.575
	(0.212)	(0.174)	(0.322)	(0.341)
Constant	1,023***	713.6***	181.5***	85.81***
	(898.4)	(616.3)	(117.2)	(51.13)
Observations	**8120**	**8120**	**8143**	**8143**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The results show that men are less respectful of barrier measures compared to women in both Morocco and Tunisia. The marital status is significant only in the case of Tunisia for never married compared to ever married. This means that single people respect less barrier measures compared to ever married. Maybe this is due to the fact that ever-married people are more careful out of fear for their family and/or their children. For the variable age, it appears that the oldest are more careful, they respect the barrier measures more (they believe that they are more vulnerable) compared to the youngest. In Tunisia, people living in urban areas respect barrier measures more than people living in rural areas. Perhaps this is due to the fact that people living in urban areas are better informed about the barrier measures to

be respected (access to communication channels, internet, etc.) compared to people living in rural areas. We find an opposite result in the case of Morocco, an unexpected result. People living in rural areas are more likely to respect barrier measures compared to those living in urban areas. For education, the results show overall that educated people respect barrier measures more. The higher the level of education, the more important compliance with the measures is. Noting that this variable is not highly significant in both Morocco and Tunisia. The probability to respect the barrier measures decreases with the number of children under age six in the household. With many children's in the household it's very difficult to respect the barriers measures in particular social distancing. This variable is significant only in Tunisia. In Morocco as in Tunisia, the variable number of children enrolled in school is not significant. Also in both countries, We find that the individuals working as formal employees or that are unemployed comply more with barrier measures compared to individuals working on their own account. When including the variable worried about being infected with Covid-19, it appears that the most worried people respect more the barrier measures. It is necessary to take this result with prudence insofar as this variable is probably endogenous. We have also introduced the waves variable, and the results show that the respect of the barriers measures is less and less important from one wave to another. This means that there is a relaxation in the respect of the Covid-19 barrier measures over time.

Table 18: Determinants of observed safety measures in Algeria

	Period 1						Period 2						Period 3					
	Total	Total	Men	Men	Women	Women	Total	Total	Men	Men	Women	Women	Total	Total	Men	Men	Women	Women
Socio-demographic characteristics																		
Sex (ref : Women) Men	-0.113 (0.0909)	-0.0396 (0.0924)	---	---	---	---	-0.143 (0.0911)	-0.0701 (0.0928)	---	---	---	---	-0.155* (0.0801)	-0.121 (0.0807)	---	---	---	---
Age	0.00877** (0.00403)	0.00849** (0.00405)	0.00580 (0.00702)	0.00789 (0.00720)	0.0101* (0.00521)	0.00927* (0.00522)	0.00138 (0.00406)	0.000930 (0.00410)	-0.0113 (0.00720)	-0.00941 (0.00735)	0.00592 (0.00529)	0.00414 (0.00531)	0.00620* (0.00365)	0.00585 (0.00366)	0.000706 (0.00630)	0.00174 (0.00635)	0.00869* (0.00473)	0.00724 (0.00476)
Marital status (ref: Ever Married) Never married	-0.0381 (0.108)	0.00370 (0.109)	-0.168 (0.201)	-0.107 (0.205)	-0.0479 (0.133)	-0.0146 (0.134)	-0.285*** (0.109)	-0.232** (0.110)	-0.672*** (0.209)	-0.612*** (0.213)	-0.187 (0.134)	-0.135 (0.135)	-0.0913 (0.0982)	-0.0599 (0.0988)	-0.268 (0.180)	-0.236 (0.181)	-0.0598 (0.121)	-0.0220 (0.122)
Stratum (ref : rural) Urban	0.319*** (0.0741)	0.267*** (0.0751)	0.195* (0.118)	0.106 (0.121)	0.397*** (0.0971)	0.362*** (0.0979)	0.405*** (0.0747)	0.345*** (0.0759)	0.268** (0.119)	0.192 (0.122)	0.502*** (0.0981)	0.455*** (0.0991)	0.277*** (0.0669)	0.239*** (0.0676)	0.201* (0.106)	0.171 (0.108)	0.326*** (0.0871)	0.293*** (0.0879)
Educational Attainment (ref: Less than basic)																		
Basic	0.302** (0.128)	0.286** (0.129)	0.710*** (0.240)	0.871*** (0.246)	0.203 (0.157)	0.150 (0.158)	0.119 (0.130)	0.112 (0.130)	0.451* (0.239)	0.577** (0.243)	0.0450 (0.159)	-0.00922 (0.160)	0.185 (0.120)	0.174 (0.121)	0.474** (0.229)	0.522** (0.231)	0.127 (0.145)	0.0813 (0.146)
Secondary	0.536*** (0.141)	0.487*** (0.142)	1.212*** (0.260)	1.328*** (0.266)	0.256 (0.174)	0.193 (0.176)	0.412*** (0.143)	0.373*** (0.143)	0.916*** (0.257)	1.010*** (0.261)	0.248 (0.179)	0.164 (0.180)	0.454*** (0.130)	0.423*** (0.131)	0.939*** (0.242)	0.962*** (0.243)	0.265* (0.160)	0.204 (0.161)
Higher education	0.578*** (0.153)	0.486*** (0.154)	1.081*** (0.271)	1.126*** (0.277)	0.411** (0.198)	0.327 (0.201)	0.567*** (0.157)	0.479*** (0.158)	1.103*** (0.277)	1.147*** (0.282)	0.394* (0.204)	0.267 (0.206)	0.463*** (0.141)	0.403*** (0.142)	0.778*** (0.253)	0.776*** (0.254)	0.398** (0.181)	0.302* (0.183)
Household characteristics																		
Household size	-0.0588 (0.0529)	-0.0573 (0.0534)	-0.0274 (0.0865)	-0.0573 (0.0898)	-0.0596 (0.0691)	-0.0548 (0.0696)	-0.0883 (0.0547)	-0.0831 (0.0554)	0.000373 (0.0856)	-0.0181 (0.0879)	-0.140* (0.0737)	-0.123* (0.0742)	-0.139*** (0.0493)	-0.138*** (0.0496)	-0.0675 (0.0776)	-0.0788 (0.0782)	-0.175*** (0.0658)	-0.162** (0.0661)
Household size square	-0.00171 (0.00367)	-0.00225 (0.00370)	-0.00634 (0.00639)	-0.00419 (0.00659)	-0.00103 (0.00465)	-0.00179 (0.00467)	0.00520 (0.00388)	0.00463 (0.00394)	-0.00379 (0.00642)	-0.00208 (0.00656)	0.00985* (0.00509)	0.00831 (0.00513)	0.00981*** (0.00356)	0.00967*** (0.00358)	0.00253 (0.00589)	0.00356 (0.00593)	0.0132*** (0.00464)	0.0121*** (0.00467)
Number of children under age six in the household	-0.0142 (0.0515)	-0.000970 (0.0520)	-0.101 (0.0830)	-0.1000 (0.0858)	0.0363 (0.0685)	0.0451 (0.0691)	-0.0603 (0.0534)	-0.0488 (0.0540)	-0.100 (0.0859)	-0.0894 (0.0882)	-0.0500 (0.0713)	-0.0488 (0.0718)	-0.0474 (0.0482)	-0.0413 (0.0484)	-0.102 (0.0761)	-0.102 (0.0770)	-0.0230 (0.0647)	-0.0288 (0.0650)
Labor market situation (ref: Non-wage)																		
Formal	0.174 (0.141)	0.203 (0.142)	0.124 (0.189)	0.161 (0.191)	0.205 (0.234)	0.235 (0.235)	-0.0502 (0.139)	-0.0303 (0.140)	-0.108 (0.182)	-0.0988 (0.184)	0.0657 (0.235)	0.0974 (0.236)	-0.00544 (0.120)	0.0117 (0.120)	0.0236 (0.161)	0.0372 (0.162)	-0.0180 (0.193)	-7.25e-05 (0.193)
Informal	-0.413 (0.282)	-0.394 (0.287)	-0.277 (0.366)	-0.270 (0.379)	-0.649 (0.454)	-0.641 (0.458)	-0.449 (0.287)	-0.422 (0.295)	-0.336 (0.367)	-0.330 (0.380)	-0.664 (0.464)	-0.608 (0.474)	-0.360 (0.271)	-0.354 (0.273)	-0.219 (0.354)	-0.229 (0.360)	-0.563 (0.427)	-0.537 (0.430)
Unemployed	-0.256* (0.139)	-0.141 (0.142)	-0.179 (0.170)	-0.00125 (0.175)	-0.324 (0.279)	-0.267 (0.281)	-0.328** (0.140)	-0.214 (0.143)	-0.211 (0.171)	-0.0607 (0.176)	-0.343 (0.281)	-0.278 (0.285)	-0.432*** (0.129)	-0.370*** (0.130)	-0.378** (0.156)	-0.302* (0.158)	-0.424* (0.254)	-0.410 (0.257)
Out of labor force	0.0542 (0.104)	0.0729 (0.105)	0.0785 (0.149)	0.0984 (0.155)	-0.0198 (0.173)	0.00123 (0.173)	-0.0612 (0.106)	-0.0472 (0.108)	-0.0513 (0.149)	-0.0494 (0.154)	-0.0490 (0.177)	-0.0327 (0.178)	-0.0103 (0.0923)	0.00217 (0.0927)	0.00341 (0.132)	-0.00748 (0.133)	-0.0237 (0.151)	-0.0133 (0.151)
Worried about being infected with COVID-19 (ref: Very Worried)																		
Not at all| worried	---	-0.754*** (0.112)	---	-1.149*** (0.165)	---	-0.468*** (0.165)	---	-0.828*** (0.112)	---	-1.025*** (0.162)	---	-0.628*** (0.167)	---	-0.472*** (0.104)	---	-0.517*** (0.144)	---	-0.364** (0.157)
A little worried	---	-0.326*** (0.102)	---	-0.578*** (0.177)	---	-0.206 (0.127)	---	-0.446*** (0.102)	---	-0.522*** (0.175)	---	-0.423*** (0.128)	---	-0.288*** (0.0910)	---	-0.0842 (0.153)	---	-0.401*** (0.115)
Rather worried	---	-0.0871 (0.0891)	---	-0.452*** (0.152)	---	0.102 (0.113)	---	-0.159* (0.0916)	---	-0.337** (0.154)	---	-0.0642 (0.116)	---	-0.0874 (0.0775)	---	-0.0633 (0.126)	---	-0.102 (0.0990)
/cut1	-1.453*** (0.317)	-1.727*** (0.324)	-1.064** (0.506)	-1.556*** (0.528)	-1.590*** (0.427)	-1.748*** (0.435)	-1.595*** (0.322)	-1.898*** (0.329)	-1.535*** (0.512)	-1.873*** (0.527)	-1.627*** (0.440)	-1.925*** (0.448)	-1.068*** (0.284)	-1.242*** (0.289)	-0.738 (0.453)	-0.835* (0.461)	-1.137*** (0.381)	-1.373*** (0.389)
/cut2	-1.026*** (0.315)	-1.266*** (0.321)	-0.717 (0.504)	-1.154** (0.525)	-1.087** (0.424)	-1.225*** (0.430)	-1.268*** (0.321)	-1.548*** (0.328)	-1.274** (0.510)	-1.588*** (0.525)	-1.234*** (0.438)	-1.514*** (0.446)	-0.668** (0.283)	-0.835*** (0.288)	-0.380 (0.453)	-0.465 (0.460)	-0.701* (0.380)	-0.929** (0.388)
/cut3	-0.217 (0.314)	-0.427 (0.319)	0.132 (0.503)	-0.227 (0.523)	-0.290 (0.422)	-0.415 (0.428)	-0.735** (0.320)	-0.991*** (0.326)	-0.761 (0.509)	-1.038** (0.523)	-0.676 (0.436)	-0.939** (0.444)	-0.212 (0.283)	-0.374 (0.287)	0.0774 (0.453)	-0.00169 (0.460)	-0.240 (0.379)	-0.463 (0.387)
Observations	**1517**	**1517**	**599**	**599**	**918**	**918**	**1517**	**1517**	**599**	**599**	**918**	**918**	**1517**	**1517**	**599**	**599**	**918**	**918**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

In the case of Algeria (Table 18), the results show that the gender variable is significant only for the third period with a negative effect for men, which means that men respect the barrier measures less than women. Marital status is significant for the second period (July 2020- September 2020) with a negative effect for single men compared to men in other situations (married, divorced, etc.). Note that this variable is not significant for women. The residence stratum is significant for both men and women for all three periods with a positive effect for those residing in urban areas compared to those residing in rural areas. This means that people who live in urban areas respect barrier measures more than rural people. Note that the effect of this variable is greater for women than for men. This means that women in urban areas respect barrier measures more than men residing in urban areas. The level of education is significant for both men and women for all three periods. Compliance with barrier measures is positively correlated with the level of education. This means that educated people are more likely to respect barrier measures compared to less educated people. We introduced household size into the model, the variable is significant only for women with a concave effect. This means that compliance with barrier measures increases with household

size up to a certain size (inflection point) after compliance with barrier measures gradually decreases. After a certain size of the household, it is difficult to respect the barrier measures by the members of the household. It appears from the results that the presence of children in the base age (less than 6 years) is not significant. Unemployed people are less likely to respect the barrier measures against Covid-19 compared to self-employed people. A possible interpretation, the unemployed do not have the financial means to buy the masks, the gel, and therefore they do not respect the barrier measures by constraint and not by choice. The stress variable is significant for both men and women for all three periods. The results show that the stress variable is positively correlated with the number of barrier measures respected. This means that the more the stress increases, the more individuals will respect the barrier measures against Covid-19.

Determinants of the intensity of observed safety measures

The used ordred probit model allows us the obtention of the results summarized in Tables 19 $-$ 20.

Table 19: Determinants of the intensity of observed safety measures - marginal effects

	Morocco		Tunisia	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Socio-demographic characteristics				
Sex (ref: Women)	0.0121***	0.0168***	0.0196***	0.0357***
Men	(0.00190)	(0.00210)	(0.00193)	(0.00261)
Marital status (ref: Ever Married)	0.00694***	0.00869***	0.0131***	0.0208***
Never married	(0.00254)	(0.00283)	(0.00289)	(0.00384)
Age (ref:18-24 years)				
25-34 years	-0.00284	-0.00209	-0.00200	0.00126
	(0.00247)	(0.00279)	(0.00252)	(0.00352)
35-54 years	-0.00850***	-0.00727**	-0.00588**	-0.00401
	(0.00281)	(0.00312)	(0.00290)	(0.00379)
55-64 years	-0.0140***	-0.0137***	-0.0153***	-0.0162***
	(0.00226)	(0.00274)	(0.00226)	(0.00332)
Stratum (ref : rural)				
Urban	0.00435**	0.00540***	0.000670	0.000421
	(0.00187)	(0.00207)	(0.00168)	(0.00221)
Camp	---	---	---	---
Educational Attainment (ref: Less than basic)				
Basic	0.00724**	0.00687**	0.00709**	0.00931**
	(0.00292)	(0.00314)	(0.00293)	(0.00377)
Secondary	0.00387	0.00312	0.00360	0.00573**
	(0.00282)	(0.00304)	(0.00219)	(0.00287)
Higher education	0.0124***	0.0125***	0.00182	-0.00128
	(0.00311)	(0.00334)	(0.00257)	(0.00315)
Household characteristics				
Household size	0.000402	0.000398	0.000330	0.000412
	(0.000593)	(0.000658)	(0.000807)	(0.00104)
Household size square	1.30e-06	4.85e-06	-3.27e-05	-3.94e-05
	(1.96e-05)	(2.16e-05)	(4.32e-05)	(5.33e-05)
Number of children under age six in the household	0.00118	0.00171	0.00355***	0.00371***
	(0.00109)	(0.00121)	(0.00101)	(0.00132)
Number of children enrolled in school	0.000606	0.000476	-0.00111	-0.00209**
	(0.000760)	(0.000845)	(0.000729)	(0.000956)
Labor market situation				
(ref: Non-wage)				
Formal	-0.0110***	-0.0126***	-0.00845***	-0.0140***
	(0.00199)	(0.00220)	(0.00184)	(0.00234)
Informal	0.000316	4.68e-05	-0.00207	-0.00429
	(0.00291)	(0.00320)	(0.00219)	(0.00280)
Unemployed	-0.00605***	-0.00660***	-0.00629***	-0.00967***
	(0.00212)	(0.00237)	(0.00196)	(0.00253)
Out of labor force	-0.00192	-0.00193	-0.00241	-0.00491
	(0.00240)	(0.00269)	(0.00242)	(0.00308)
Worried about being infected with COVID-19 (ref: Very Worried)				
Not at all| worried	0.0255***	---	0.0637***	---
	(0.00299)		(0.00498)	
A little worried	-0.00162	---	0.0192***	---
	(0.00249)		(0.00350)	
Rather worried	0.00563	---	-0.000194	---
	(0.00451)		(0.00305)	
Wave (ref: Wave 1)				
Wave 2	0.0123***	0.0178***	0.0116***	0.0136***
	(0.00329)	(0.00384)	(0.00274)	(0.00341)
Wave 3	0.0134***	0.0199***	0.0221***	0.0260***
	(0.00335)	(0.00394)	(0.00328)	(0.00395)
Observations	**8120**	**8120**	**8143**	**8143**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 20: Determinants of the intensity of observed safety measures - Wave interaction

	Morocco		Tunisia	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Socio-demographic characteristics				
Sex (ref: Women)	-0.149*	-0.223***	-0.370***	-0.524***
Men	(0.0875)	(0.0864)	(0.0717)	(0.0694)
Wave # Sex (ref: wave 1 * women)				
Wave 2# Sex	-0.0107	-0.00196	-0.0619	-0.0493
	(0.113)	(0.112)	(0.0958)	(0.0932)
Wave 3 # Sex	-0.324***	-0.295**	-0.0873	-0.114
	(0.116)	(0.115)	(0.0940)	(0.0915)
Marital status (ref: Ever Married)	-0.355***	-0.362***	-0.173**	-0.217***
Never married	(0.0899)	(0.0887)	(0.0764)	(0.0744)
Wave # Marital status (ref: wave 1 * Ever Married)				
Wave 2 # Marital status	0.173	0.161	-0.0750	-0.0761
	(0.113)	(0.112)	(0.0932)	(0.0910)
Wave 3 # Marital status	0.278**	0.255**	-0.106	-0.0834
	(0.112)	(0.111)	(0.0923)	(0.0903)
Age (ref:18-24 years)				
25-34 years	0.0598	0.0397	0.0434	-0.0164
	(0.0529)	(0.0524)	(0.0534)	(0.0522)
35-54 years	0.181***	0.139**	0.121**	0.0625
	(0.0592)	(0.0585)	(0.0588)	(0.0575)
55-64 years	0.386***	0.322***	0.408***	0.298***
	(0.0807)	(0.0797)	(0.0742)	(0.0721)
Stratum (ref : rural)	-0.0778	-0.0762	-0.0352	-0.0226
	(0.0907)	(0.0895)	(0.0728)	(0.0708)
Wave # Urban (ref: wave 1 # rural)				
Wave 2 # Urban	-0.0528	-0.0536	0.0494	0.0504
	(0.120)	(0.119)	(0.0987)	(0.0962)
Wave 3 # Urban	-0.0755	-0.0996	0.108	0.0851
	(0.124)	(0.123)	(0.0968)	(0.0945)
Educational Attainment (ref: Less than basic)				
Basic	-0.152	-0.129	-0.173*	-0.222**
	(0.107)	(0.106)	(0.105)	(0.102)
Secondary	0.0163	0.0563	0.00850	0.0111
	(0.121)	(0.121)	(0.0899)	(0.0873)
Higher education	0.0230	0.0339	0.121	0.171*
	(0.122)	(0.120)	(0.105)	(0.102)
Wave 2 # Basic	-0.0127	-0.00642	0.0832	0.130
	(0.144)	(0.142)	(0.141)	(0.137)
Wave 2 # Secondary	-0.0332	-0.0999	-0.0446	-0.0731
	(0.161)	(0.159)	(0.120)	(0.117)
Wave 2 # Higher education	-0.286*	-0.293*	-0.126	-0.114
	(0.155)	(0.153)	(0.139)	(0.136)
Wave 3 # Basic	-0.0528	-0.0747	0.123	0.199
	(0.146)	(0.145)	(0.139)	(0.135)
Wave 3 # Secondary	-0.233	-0.255	-0.104	-0.118
	(0.160)	(0.159)	(0.118)	(0.115)
Wave 3 # Higher education	-0.256*	-0.253*	-0.184	-0.183
	(0.154)	(0.152)	(0.137)	(0.134)
Household characteristics				
Household size	-0.00892	-0.00816	-0.00641	-0.00606
	(0.0121)	(0.0120)	(0.0164)	(0.0157)
Household size square	-4.22e-05	-9.26e-05	0.000658	0.000595
	(0.000397)	(0.000393)	(0.000877)	(0.000808)
Number of children under age six in the household	-0.0218	-0.0287	-0.0717***	-0.0558***
	(0.0223)	(0.0221)	(0.0202)	(0.0198)
Number of children enrolled in school	-0.0120	-0.00800	0.0225	0.0319**
	(0.0156)	(0.0154)	(0.0148)	(0.0144)
Labor market situation				
(ref: Non-wage)				
Formal	0.277***	0.285***	0.192***	0.241***
	(0.0565)	(0.0559)	(0.0447)	(0.0436)
Informal	-0.00558	0.00126	0.0427	0.0680
	(0.0590)	(0.0583)	(0.0473)	(0.0463)
Unemployed	0.138***	0.134***	0.136***	0.157***
	(0.0508)	(0.0503)	(0.0458)	(0.0448)
Out of labor force	0.0457	0.0419	0.0500	0.0764
	(0.0510)	(0.0506)	(0.0524)	(0.0512)
Worried about being infected with COVID-19 (ref: Very Worried)				
Not at all| worried	-0.478***	---	-0.934***	---
	(0.0455)		(0.0461)	
A little worried	0.0285	---	-0.328***	---
	(0.0527)		(0.0499)	
Rather worried	-0.113	---	0.00286	---
	(0.0771)		(0.0623)	
Wave (ref: wave 1)				
Wave 2	-0.193	-0.236*	-0.144	-0.130
	(0.131)	(0.129)	(0.123)	(0.120)
Wave 3	0.0340	-0.0211	-0.285**	-0.234**
	(0.139)	(0.137)	(0.121)	(0.117)
/cut1	-2.724***	-2.571***	-2.789***	-2.276***
	(0.133)	(0.129)	(0.134)	(0.126)
/cut2	-2.270***	-2.133***	-2.216***	-1.750***
	(0.131)	(0.127)	(0.133)	(0.124)
/cut3	-1.704***	-1.585***	-1.479***	-1.068***
	(0.130)	(0.126)	(0.132)	(0.123)
Observations	**8120**	**8120**	**8143**	**8143**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

In the analysis of the determinants of observed safety measures, we found that women respect the barrier measures more than men. On the other hand, the analysis of the intensity (number) of measures to be respected, it appears for the case of Morocco and Tunisia that

men respect more measures (number of measures) compared to women. The Never married respect more barrier measures compared to ever married in both countries. For the age variable, we found in the first analysis (determinants of respect for barrier measures) that elderly respect barrier measures more than youth. On the other hand, in the analysis of intensity of observed safety measures, it appears for all the countries considered that the oldest comply with fewer measures compared to the youngest. The stratum of residence is significant only for the case of Morocco, where it appears that people living in urban areas use more barrier measures compared to people living in rural areas. For the level of education, there are contrasting results between countries. Indeed, for Morocco, educated people use more barriers against Covid-19 compared to people with a low level of education. For household characteristics, we introduced three variables into the model: household size, number of children under six in the household, and number of children enrolled in school. Household size is not significant for both Morocco and Tunisia. The number of children under age six in the household is significant only in the case of Tunisia. The more children under six old there are in the household, the more members of the household use several measures to protect against Covid-19. Furthermore, the variable number of children enrolled in school is not significant in both Morocco and Tunisia. Working status has an effect on the use of Covid-19 barrier measures. The results show that individuals in a formal salaried and unemployed position use fewer barrier methods compared to individuals in a self-employed position. We have found an opposite result in the first model "determinant of observed safety measures" formal salaried and unemployed respect more the barrier measures compared to self-employed workers. When including the variable worried about being infected with Covid-19, it appears that the most worried people respect more barrier methods measures. In the first analysis "determinant of observed safety measures" the results show that the respect of the barriers measures is less and less important from one wave to another. This means that there is a relaxation in the respect of the Covid-19 barrier measures over time. Nevertheless, in the analysis of "determinants of the intensity of observed safety measures", the results show that individuals who respect the measures are using more and more barrier methods against Covid-19 over time.

3. Discussion

The obtained results show that the safety measures are not perceived similarly in the three countries. In Algeria, we notice a high use of social distancing in both first and second period; however this measure is mostly replaced by the wearing mask and washing hands measures in the third period. The firstly large use of the social distancing can be explained by the fact that the first evoked reason of the non-compliance to the safety measures is their discomfort. It is then obvious that the social distancing is the less uncomfortable one. Furthermore, $\simeq 94$% of Algerians argued that they observe the safety measures to avoid virus' contamination, also $\simeq 65.5$% state that their stress increased after experiencing a neighborhood death caused by Covid-19[2]. These observations justify the large use of the mask in the third period. In fact, the fear of being infected and the experienced two contamination waves' incited people to use

[2]These results are obtained using the CAPI$-$CREAD study

more restrictive safety measure, despite of its discomfort. In Morocco, the social distancing is not as used as the wearing mask or washing hands. In addition, we notice some constancy in the Moroccans behavior toward the safety measures use. As no questions were asked concerning their motivations concerning the safety measures' use, we essentially focus on the infected cases' number to explain this result. In this direction, one can see that, unlike the Algerian or the Tunisian case, where an alternation of the increase and the decrease of confirmed cases is noticed all over the studied period, the Moroccans case shows a high contaminated number until the first wave of the study, then an important decrease. It seems like Morocco experienced a contaminated wave as one important bloc happening until November 2020 (see Figures 1). It could be one of the reasons that makes Moroccans more respectful. In fact, a continuous high contamination number all along five months, without any decrease, can generate more awareness. The Tunisians' case differs from both Algerians' and Moroccans' cases. In fact, the wearing mask measure is mostly observed in the first wave whereas the social distancing measure is mostly used in the two last waves. Supposing that the wearing mask measure is also considered too uncomfortable by Tunisians, we can explain their behavior by the outbreak high decline in the second wave (see Figure 1). Thereby, they switch to the less uncomfortable measure which is the social distancing. However, they do not change their behavior in the third wave despite outbreak recrudescence.

The number of safety measures observed per person is a very important parameter in the reduction of the virus spread. In fact, combining two or more safety measures such as: social distancing and wearing a mask can be as effective as the shelter-in-place measure Li et al. (2020). In this regard, the simulations of the number of observed safety measures show convergence to steady states in all countries. With about 80% of people observing three safety measures, Morocco is considered as the better country in term of observed safety measures' number. In Tunisia, the percentage of people keeping three safety measures use is less important than in Morocco, but stills correct. Indeed, one over two Tunisians continues to observe three safety measures. Furthermore, the number of Tunisians observing two safety measures converges to 19% and is more important than the percentage of people observing one safety measure or no safety measure at all. In Algeria, the percentage of people observing no safety measure converges to 82%, making by the Algerian case the worst one among the three countries. However, such behavior allows the gain of herd immunity Atlani-Duault et al. (2021). Indeed, one can observe that after the second important contamination wave, which happened in November 2020, the number of infected persons is negligible compared to the recovered persons (see Figure 1). The only explanation of this decreasing number of contaminated persons although the low percentage of people observing the safety measures in that period (period 3), is the gain of herd immunity. Unfortunately, the emergence of the new variant of the virus (Delta) disrupted this situation and caused a new frightful contamination wave.

Conclusion

In this work, we investigate the use of the safety measures in each of: Algeria, Morocco, and Tunisia. In this direction, we consider the data of ERF and CREAD among three periods of time.

Then we perform the data analysis following the used safety measures' kind, and the number of used safety measures. When considering the used safety measures' kind, the results show that Moroccans are more respectful toward each safety measure compared to Algerians or Tunisians. Also, a common decrease in the percentage of people observing each safety measure is noticed for all countries. Except for the wearing mask measure in Algeria, where an increase in the number of people doing it is noticed from July 2020 to September 2020. The percentage of people respecting each safety measure is greater than 80% for both Morocco and Tunisia, whatever the period. In Algeria, these percentages fall below 80% from October 2020 to May 2021. Focusing on the variables: gender, age, educational level and residence region, and their effects on the populations' behavior toward each safety measure, it appears that:

(i) These effects differ following: the country, the safety measure kind, and the period of time. In this regard, the variables which have a significant effect, whatever the safety measure kind, and over the three periods of time are:

- residence region and educational level in Algeria, in such a way that urban people and those having a high educational level are the most respectful
- Gender and age in Morocco, in such a way that women and the oldest are the most respectful
- Gender in Tunisia, where women are more respectful than men.

(ii) Even in the same country, the most used safety measure is not generally the same all over the time, whatever the variable. However, urban people mostly use social distancing in Algeria, men mostly use the measure "wear a mask" in Morocco, and Men mostly use social distancing, whereas women mostly use the measure " wear a mask" in Tunisia.

When focusing on the number of used safety measures, several simulations based on transition graphs show that, the percentage of people observing three safety measures in Morocco converges to 80%, against 59% in Tunisia and only 5% in Algeria.

Furthermore, the used statistical models to study both the determinants of the use of at least one safety measure and the intensity of the used safety measures show that: in all countries, although women mostly observe the safety measures, men are those who use them more intensively. In the same way, elderly comply more widely with the barrier methods, whereas youth are those who use them intensively.

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