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Economic Impacts of the COVID-19 Pandemic on Workers' Incomes: Evidence from Arab Countries

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ABSTRACT

The COVID-19-induced economic downturn has increased unemployment and income losses in many countries. Arab countries have suffered negative impacts of the COVID-19 pandemic. This study assessed the extent to which COVID-19 has impacted workers' incomes in five Arab countries (Egypt, Jordan, Sudan, Morocco, and Tunisia), based on the COVID-19 MENA Monitor Household Survey. The study estimated the main drivers of income changes during the pandemic using the random effect ordinal logistic model. Workers who maintained the same working hours before the pandemic experienced positive income changes in Egypt, Tunisia, and Jordan. Regular work increased the odds of experiencing positive income changes in Tunisia and Jordan. Workers in the food and accommodation sector were the most exposed to negative changes in income in Egypt and Tunisia. Blue-collar workers showed a higher chance of experiencing income reduction in Morocco. Social insurance and teleworking were not significant drivers of income changes in most surveyed countries. The pandemic crisis reveals the need to strengthen social protection systems in Arab countries and protect vulnerable workers in such future crises.

INTRODUCTION

COVID-19 is a public health crisis of international concern. All countries have taken the necessary measures to confront the spread of the pandemic by closing schools and universities, suspending flights and gatherings, and reduced working days. Similar pre-cautionary measures and policy responses to COVID-19 have been applied in Arab countries to prevent the virus spread (Krafft et al., 2021a) The unprecedented measures taken to contain the COVID-19 outbreak have caused severe economic losses. These adverse economic implications hit Arab countries at both macro and micro levels (Eldeep and Zaki,

2022). The economic situation of workers in Arab countries has deteriorated due to these movement restrictions and labour market distributions. The livelihoods of vulnerable groups, including informal workers and daily wage earners, have been hit hard (Krafft et al., 2022). Assessing the extent to which COVID-19 has impacted workers' incomes is an urgent matter in assessing the government's responses and designing policies more compatible with the repercussions of the pandemic.

COVID-19 has a distinctive impact on the distribution of jobs and earnings compared to previous recessions. Women-dominated industries were more likely to be severely affected during the pandemic than the previous downturns in which male-dominated industries faltered. Lockdown and social distancing measures related to the pandemic have affected sectors that require personal interaction. Females are overrepresented in these lockdown sectors, such as home services, childcare homes, and customer services (Alon et al, 2020). However, women's incomes are not necessarily more affected than men's during the pandemic. Adams-Prassl et al. (2020) demonstrated that the gender gap in the probability of losing income was insignificant. Moreover, some industries dominated by women continued to work during the pandemic. Women working in educational activities were able to maintain their jobs using distance learning techniques. Meanwhile, some sectors in which men are concentrated, such as construction, manufacturing, and other industries, have been suspended (Hupkau and Petrongolo, 2020).

The unemployment rate has increased substantially in Arab countries since the onset of the pandemic (Krafft et al., 2021b). According to rapid labour force surveys conducted by Economic Re-search Forum (ERF), the unemployment shares within the surveyed population increased by 29% in Morocco and 33% in Tunisia since the onset of the COVID pandemic. Highly educated individuals were the most affected by increasing unemployment rates in Morocco; secondary educated workers saw a 70% increase in the unemployment rate. In contrast, workers with secondary education in Tunisia were less affected compared to those with or less than basic education. The unemployment rate increased dramatically among male workers, and informal workers in both countries (International Labour Organization, 2021a,b). In Egypt, the COVID-19-induced increase in economic inactivity (4%) was higher than that of unemployment (3). 16% of unemployed respondents before the COVID-19 outbreak became in-active and dropped out of the labour force. Females were more likely to fall into economic inactivity while males were more likely to be unemployed; the unemployment rate has doubled among males. Moreover, the share of females in employment dropped by 10% versus 8% for males (International Labour Organization, 2021c). Employment losses were more concentrated among informal wage workers, less-educated workers, rural residents, wage workers for the private sector, and farmers. While unemployment losses less impacted employees in the public sector and business owners (Blundell et al., 2020).

Several studies have demonstrated that demographic characteristics highly predicted the probability of income changes. Adams-Prassl et al. (2020); Blundell et al. (2020) and Montenovo et al. (2020) found younger workers have suffered more from job losses and reduced income during the pandemic outbreak. At the same time, Piyapromdee and Spittal (2020) indicated that the employment outcomes of younger and elderly workers are more likely to be disrupted than middle-aged workers. Education has served as a protection tool against negative outcomes induced by the pandemic such as job losses and income falls (Blundell et al., 2020). High-educated workers are more likely to maintain their incomes during the pandemic, in contrast to less-educated workers who have faced significant disruption in labour market outcomes (Piyapromdee and Spittal2020). Marital status also contributes to creating differences in income between males and females. Married working women are likely to leave work due to the current circumstances of closing schools and increasing household chores, unlike unmarried females who may continue working even considering the Coronavirus crisis. The closure of kindergartens, schools, and nursing homes has increased domestic work. Shifting to online learning has doubled the responsibilities of women (Blundell et al., 2020).

During the pandemic outbreak, most available studies in Arab countries investigated labour market disruptions. In a policy brief, Krafft et al. (2022) explored the changes in house-hold incomes, participation and employment rates in Arab countries and found that poor households more experiencing income losses than households in other income quintiles. There are similar policy briefs prepared by Krafft et al. (2021a,b,c) examining the impact of COVID-19 on small and medium enterprises, vulnerable workers, small entrepreneurs, and farmers in Arab labour market. Eldeep and Zaki (2022) studied the impact of the pandemic on the Egyptian economy using a computable general equilibrium model, assessed changes

in supply and demand aspects, identified the COVID-19-induced short and long-term effects on the economy and analyzed the impact of the government's response on economic sectors. Eldeep and Zaki (2021) indicated that the Egyptian economy is negatively affected as its sources of foreign currency declined substantially. Still, these are short-term effects and will minimize in the long run. Ramadan (2022) measured determinants of the decline in household income in Jordan and indicated that workers in hard-hit sectors, informal workers, youth, women, and poor households are more likely to experience income reductions. Some studies addressed the implications of a pandemic on employment outcomes from a gender perspective and found that COVID-19 has directly ex-acerbated some of the pre-existing inequalities between males and females (Abdel-Rahman et al., 2023a,b; Barsoum and Majbour, 2021; ElBehairy et al., 2022). Although extensive research has been studied negative labour market outcomes, no single study exists which highlights the various changes induced in workers' wages the study aims to fill the knowledge gap regarding income changes in Arab countries and investigate the effects of COVID-19 on workers' incomes using data from a five-country survey in the Middle East and North Africa (MENA).

1. MATERIALS AND METHODS

The Economic Research Forum (ERF) conducted rapid labour force surveys to monitor the economic changes caused by COVID-19 in the labour market. The survey was carried out using a phone based on a random digit dialing approach. The survey included mobile phone owners between the ages of 18 and 64. Moreover, Data was collected through a series of panel surveys in five Arab countries. ERF Survey estimates pre-COVID labour characteristics (February 2020) and the evolution of labour outcomes during the pandemic outbreak. The questionnaire covers the household's demographic and socio-economic characteristics, such as labour market outcomes, education status, food security, incomes, social safety nets, social distancing and mental health, attitudes toward risks, and coping strategies. Besides, it includes specific modules for individuals, workers, farmers, women, and business owners. The questionnaire includes demographic and household characteristics, labour market status, education, food security, incomes, social safety nets, attitudes towards risks and social distancing, coping strategies, and mental health. It includes a core module, an individual module, a worker module, a farmer module, a household enterprise module, a women module, and a tracking module. The data were compiled for Morocco, Tunisia, Egypt, Sudan, and Jordan from the year 2020 to the year 2021. Table A1 provides the description, abbreviation and encoding of the main variables used in the study.

The data included four rounds for each cross-sectional unit (individual), with a total of 34,219 observations. The first wave in each country is called the base wave, and the rest of the rounds are called the panel wave. Table A2 summarizes the number of times that each respondent was met through the four rounds in the five waves. Moreover, Table A3 presents the number of observations related to the maximum number of rounds according to the country name. It is evident from the tables that we will lose lots of information if we keep only the same number of rounds in each country to ensure the panel balance. Hence, we chose to use all the available observations and use unbalanced panels, but we excluded the respondents with only one wave. Moreover, we included wage workers for the Government/public sector or those in the private sector who responded to the employment section in the questionnaire.

The study adopted the random effect ordinal logistic model (proportional odds model) to explore the main drivers of wage changes during the pandemic. The random effect ordinal logistic model was firstly developed by McCullagh (1980), and updated to encompass the random effect by Tutz and Hennevogl (1996). The model equation can be expressed as follows:

$$Y_{it}^{*} = \mathrm{X}_{\mathrm{it}}'\beta + v_i + \varepsilon_{it}, \qquad i = 1, \dots, n;\ t = 1, \dots, T \tag{1}$$

where Y_{it}^{*} is the latent response variable, X_{it} denotes the vector of the explanatory variables. The error can be divided into two terms, the ε_{it} (The idiosyncratic error) are distributed as logistic with mean zero and variance ${\pi^2}/{3}$ and are independent of v_i (the individual effect). i is the respondent and t is the wave number, and the observed ordered response variable y_{it} can be generated from the latent continuous response, such that:

$$y_{it} = \begin{cases} 1 & if\ y_{it}^{*} \le \theta_1 \\ 2 & if\ \theta_2 < y_{it}^{*} \le \theta_3 \\ \vdots & \vdots \\ 5 & if\ \theta_4 < y_{it}^{*} \end{cases} \quad (2)$$

where y_{it} has K (five) number of categories, $Y \in \{1, .., K\}$, θs are the cutoff points, $-\infty = \theta_0 < \theta_1 < \cdots < \theta_K = \infty$.

$$Y = k \Leftrightarrow \theta_{k-1} < Y^{*} \le \theta_k \quad (3)$$

The cumulative model derived from (3) is written as

$$P(Y \le r|x) = F(\theta_r + x'\beta),\ r = 1, \ldots, K-1 \quad (4)$$

where θ_r and β are the parameters, and F is the logistic function ($F(Z) = 1/1 + \exp(-Z)$).

The previous equation can be extended in case of random effect (unobserved heterogeneity) as follows:

$$P(Y_{it} \le r \,|\, x_{it}, v_i) = F(\theta_r + x'\beta + v_i),\ r = 1, \ldots, K-1 \quad (5)$$

where v_i is the individual effect. The thresholds will be shifted by the individual effect in the case of the random effect model. The analysis was performed separately for each country, as the number of waves differed and the social, economic, and political context couldn't be generalized for the five countries.

Estimating the model using fixed effect yields an incidental parameter problem as N ⟶ +∞ for fixed T. It's better to use the random effect model (the individual parameter is assumed to be a random variable with a certain distribution). It is commonly used in the case of the ordinal logistic model or generalized linear models in general (Croissant and Millo, 2018).

The ordered response variable is y_{it} is the change in the wage, it takes values from one to five; where one is "Decreased by more than 25% ", two is "decreased by 1%-25%", three is "stayed the same", four is "Increased by 1-25%, five is "increased by more than 25% ". The explanatory variables consist of the individual characteristics that are not changing through waves, which include gender, age, educational level, place of residence, and marital status. Additionally, the analysis will include work characteristics covariates such as the main job in February 2020, type of industry, occupation, job stability, social insurance, regularity, and working in an establishment or not. Moreover, the model encompasses variables related to work arrangements such as changes in working hours or delays in wages, and finally, the status of establishment, lay-off or suspension, work with or without payment, and can or can't work from home.

2. RESULTS

2.1 Characteristics of workers in Arab countries

COVID-19 has disrupted labour market conditions. Around three-quarters of the workers in Egypt and Sudan had their work permanently closed because of the pandemic. While in Tunisia and Morocco, more than 60% of the workers continue working with the same business hours through the available waves. Most sample wage workers didn't mention lay-off without payment through the available waves in the five countries (70% -90%). Moreover, more than 90% of the wage workers in the five countries didn't mention permanent lay-off (Figure A1 and Figure A2). In the five countries except for Egypt, most sample members didn't experience a change in business hours (60%-90%), with a slight increase in the recent waves. However, in Egypt, 63% of the wage workers in the first wave experienced a decrease in the working hours by more than 25%, but the percentage predominance in the second and the fourth waves went to "the same working hours" (Figure A3). In the four countries except for Egypt, most of the workers didn't experience a change in their wages (more than 80%). However, half of the Egyptian workers in the first wave experienced a decrease in their wages by more than 25% (Figure A4). Around 75% of Egyptian workers experienced a delay in wages in the two waves.

Similarly, in the first wave, the Moroccans, Sudanese, Tunisian, and Jordanian workers (97%, 88%, 68%, and 86%) experienced wage delays, with a slight decrease in the percentage in the upcoming waves

(Figure A5). Additionally, more than 75% of the wage workers in the five countries mentioned their inability to work from home (see Figure A6). The wage workers who mentioned the inability to work from home said that the main reason was the inability to do a job off work. Another reason that was dominant among Moroccan workers was "Not allowed to work from home", specifically in the first wave.

Negative labour market outcomes have been experienced across all educational levels. Less educated workers were the most affected: 30.68 % of them lost their jobs temporarily, and 25.02 % experienced a decrease in their hourly wages. In general, workers engaged in irregular work are the most exposed to income drops across different educational levels in Arab countries. However, less-educated workers engaged in regular work are most likely to lose a higher proportion of their incomes in Jordan. As the education level increases, the proportion decrease in income declines. Workers with basic and secondary education are the most affected in Morocco, while irregular workers generally incur high rates of income attrition across educational levels in Tunisia. The proportion decrease in income is somewhat similar among workers across different educational levels in Egypt without marked differences between regular and irregular workers (As indicated in Figure A7).

Less-educated, uninsured, private sector workers are the most affected by reduced working hours and incomes. As indicated in Figure 1, Figure 2, Figure 3, 25% of less-educated workers saw their hourly wages drop during the pandemic period compared to 12% of highly educated workers; the same is true for 26% of uninsured workers versus 12% of insured workers and 23% of private sector workers versus 7% of public sector workers. Also, the proportion of workers who have experienced a decrease in working hours varies according to worker characteristics: Wage workers with less than basic education or secondary education suffered marked reductions in their working hours more than others. For example, 29% of uninsured workers and 27% of private sector workers had reduced working hours compared with 21% of insured workers and public sector workers.

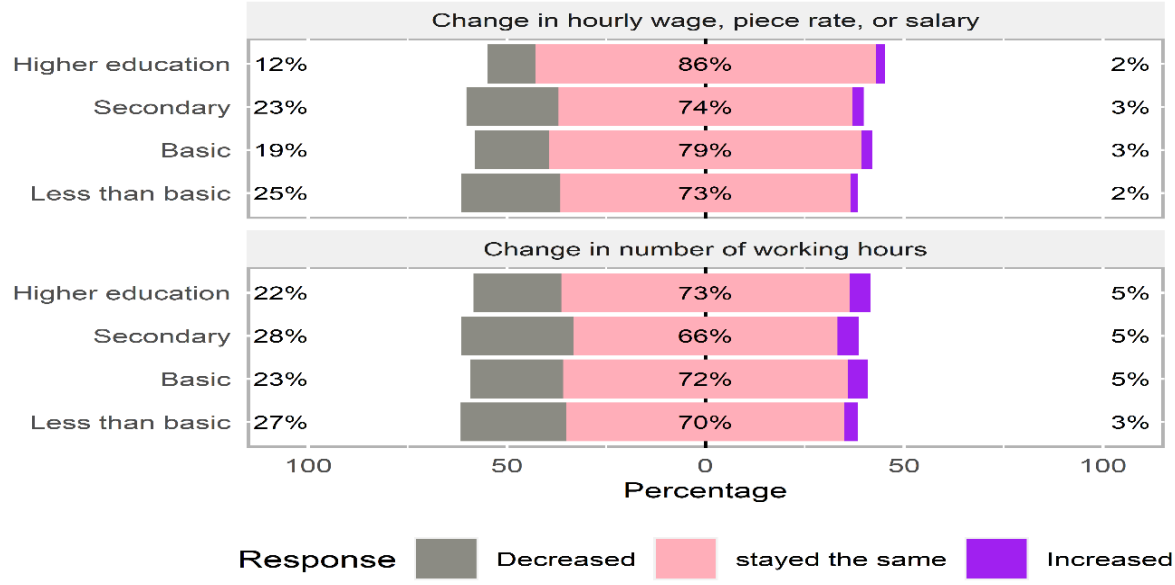

Figure 1. Changes in wages and working hours by education level
Source: own

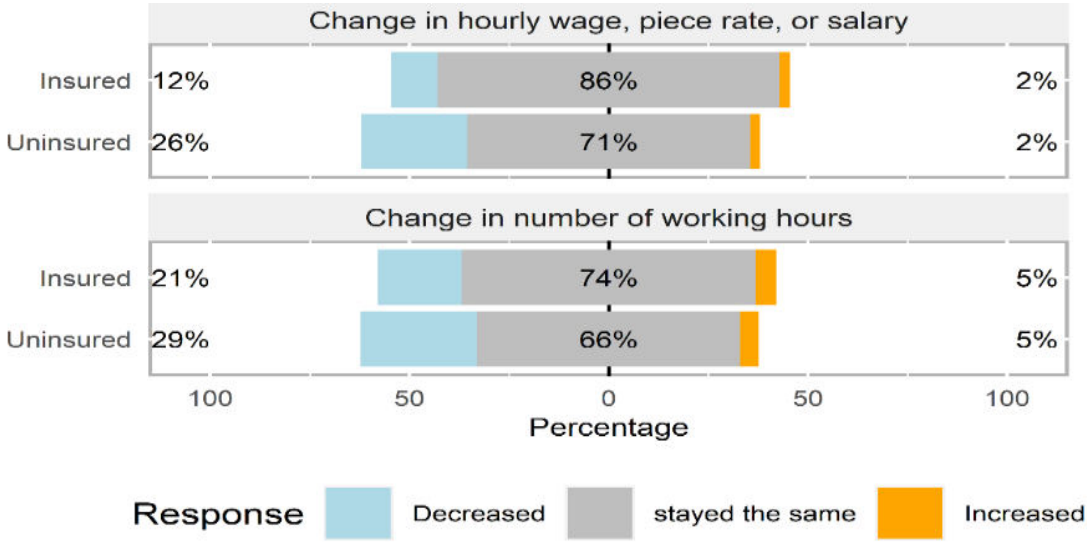

Figure 2. Changes in wages and working hours by social insurance
Source: own

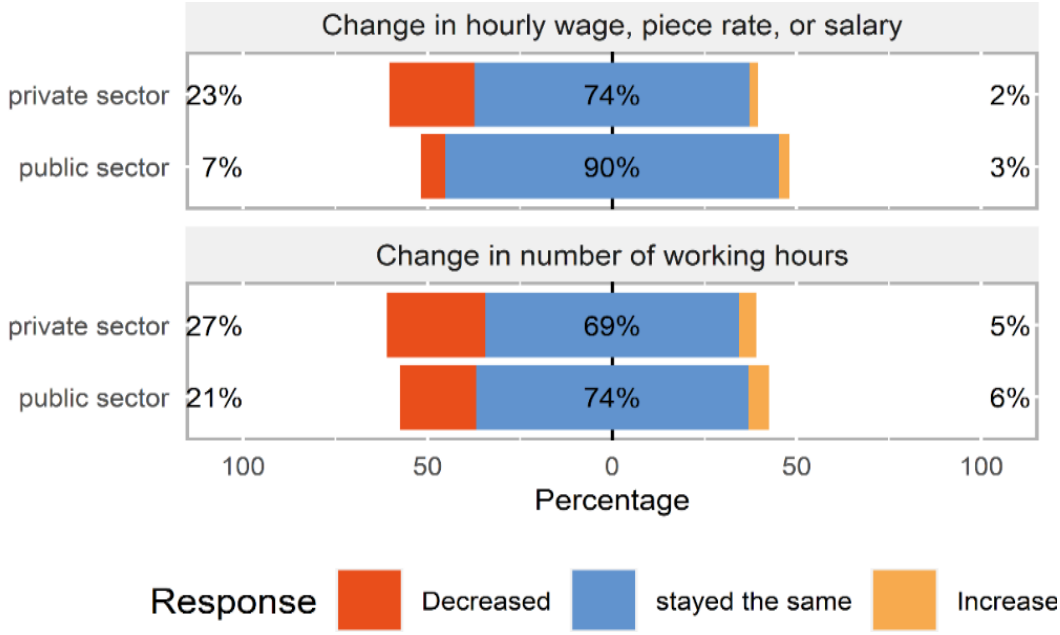

Figure 3. Changes in wages and working hours by sector
Source: own

On average, the number of working hours has changed for more than 27.6 % of workers in the surveyed countries; a quarter of workers had to work fewer hours than usual due to restrictions related to COVID-19, while 3.7 % had a 25% increase in the working hours after the COVID outbreak. Workers who experienced the largest decrease in working hours also suffered the largest decline in hourly wages. It turns out that the workers whose working hours decreased by more than 25% have endured a decrease in income by more than 25%. While the workers who kept the same number of working hours, their incomes did not change, as shown in

Figure **4**.

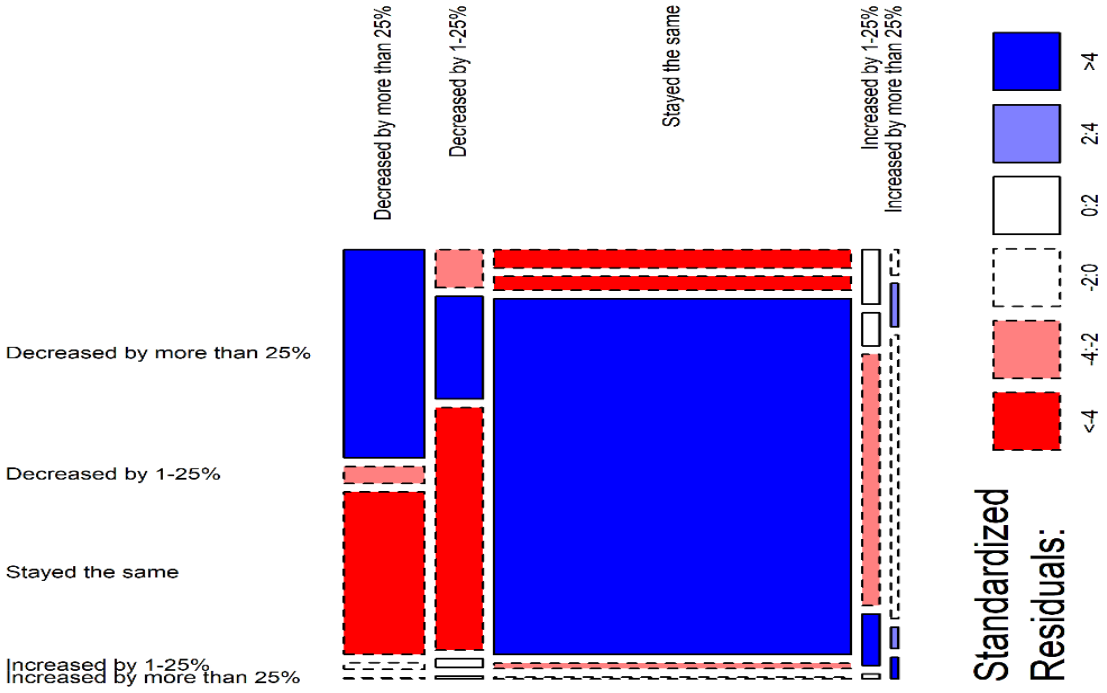

Figure 4. Mosaic plot for the relationship between changes in the hourly wage and working hours
Note**:** Both variables have the same categories. The surface of each category reflects the relative magnitude of its value. The blue surface reflects that the observed value is higher than expected, while the red reflects the opposite. The standardized residuals help to interpret the association between variables. The chi-square test indicated that they are significantly associated at a p-value less than 0.001.
Source: own

Investigating income changes across economic activities indicates that income drops have disproportionately impacted them. Workers in "Agriculture, fishing or mining" and "Construction or utilities", and "accommodation and food services" are the most affected by wage reductions compared to other activities. In contrast, workers in education and health services are less impacted by wage reductions. This result is highly expected for workers in educational activities who could shift to online and home-based work and for workers in the health sector due to the increasing pressure on the medical staff during the crisis. Moreover, health services have the largest portion of wage workers who witnessed an increase in their working hours during the COVID-19 pandemic. We also found that reporting changes in working hours varied significantly across economic activities. Although all the workers in the different activities suffer losses in their working hours, workers in "financial activities or real estate" are most likely to have reduced working hours. While workers in the health sector saw their working hours increase more than workers in other activities.

2.1 Determinants of income changes during the COVID-19 outbreak

We have conducted the Likelihood Ratio Test (LR) and the Wald test to determine the model's best fit. The LR test examines the significant difference between nested models, especially when adding the background characteristics of the respondents (Most of the demographic characteristics were insignificant except for educational level in Tunisia). However, the Wald test examines the full model and the model with restricted parameters to zero. The Wald test results were significant in the case of Egypt (P-Value<0.01), Morocco was significant (P-Value<0.1), Jordan significant (P-Value<0.01), Sudan was insignificant, and Tunisia was significant with (P-Value<0.01). The Likelihood ratio test was used to determine the variables in the model and whether there is a significant difference in the likelihood score of the nested models (better fit). The best model was stated in the paper.

The most important assumption that should be detected in the case of an ordered logistic model is the proportional odds assumption (the parallel regression assumption). This assumption states that the relationship between the different pairs of categories for the response variable is the same (only one set

of coefficients). The brant (1990) test was conducted to test the proportional odds assumption in the chosen model with the best fit with the null hypothesis (no difference in the coefficients between models), and the null hypothesis was accepted. Additionally, multicollinearity using a variance decomposition matrix was detected. The condition indices for the variables in the model are less than ten, indicating no multicollinearity in the variables under consideration, and we kept the chosen variables in the model.

Some questions were only available in one wave in Egypt and Sudan, such as work stability, social insurance, work in the establishment, and business status. The question related to the ability to work from home was available in one wave in Sudan. Accordingly, the former questions were not added to the model analysis. Additionally, we deleted some questions to avoid the multicollinearity problem. In Egypt and Sudan, we excluded permanent lay-offs and worked in the establishment. In Jordan, we excluded economic activity, permanent lay-off, lay-off without payment, work in the establishment, and occupation. In Morocco, we excluded permanent lay-off, lay-off without payment, work in establishment and economic activity. Finally, in Tunisia, we excluded permanent lay-offs and worked in the establishment.

2.1.1 Determinants of Covid-induced income changes in Egypt

Table 1 displays the proportional odds ratios1 for the determinants of Covid-induced income changes in Egypt. The odds of having an increase in wage change among respondents who didn't mention a wage delay is 0.22 the odds of being in higher levels of the wage for respondents who experienced a wage delay during the pandemic (p-value<0.05). Working in the education sector increases the odds of being beyond any category of wage change by eight times the odds of being in the food and accommodation sector. The odds of having any higher level of wage change among those who were working in agriculture and fishing (relative to stable and lower wage levels) were three times higher as compared with respondents who were working in the food and accommodation sector (OR = 3.356; 95%CI = 1.026, 10.98) with p-value <0.05. Similarly, the odds of having a higher level of positive wage change among health sector workers and other services workers (versus stable and lower wage levels) were (five and six, respectively) times higher than those who were working in the food and accommodation sector (with p-value<0.1). The other sector's types did not significantly affect the wage change. Regarding the occupation sector in February, the clerks/service workers showed a lower chance of being beyond any wage level (comparable with lower levels) than the chance for blue-collar, skilled agricultural, or production and transport (OR=0.6, p-value <0.1). Similarly, the chance of technicians/associate professionals is lower than the chance of the blue collars (OR=0.5, p-value <0.05).

The respondents who didn't experience a lay-off without payment had odds of being in increased levels of wage change two times higher than the odds in case of experiencing a lay-off, with a p-value<0.0.05. However, the change in working hours did not appear to significantly affect the wage change during the pandemic except for the category of being the same working hours. It showed that the odds of being beyond any high-wage category were four times higher than in the reference category (increased by 1-25%). As provided in Table 1, the variance of the individual effect is 0.05, and the likelihood ratio test that compares the model with individual effect and the model without individual effect didn't show a significant difference. The insignificance of the likelihood ratio test means we don't have evidence that the individual effect can explain any extra variation in the ordinal dependent variable. Thus, the insignificance can be due to the small number of respondents.

[1] The odds of being beyond category k=logit $p(Y>k) = \frac{p(Y>k)}{p(Y\leq k)}$

2.1.1 Determinants of Covid-induced income changes in Egypt

Table 1. Factors affecting wage change using random effect ordered logistic model in Egypt

Wage Change	*OR.*	*St. Err.*	*t-value*	*p-value*	*[95% Conf Interval]*	
Wage Delay						
Not mentioned	.218***	.057	-5.87	0	.131	362
Economic activity						
Education	7.865***	5.77	2.81	.005	1.867	13.128
Transportation and storage	1.186	.556	0.36	.716	.474	2.971
Agriculture, fishing	2.777*	1.66	1.71	.087	.861	8.959
Construction or utilities	1.065	.458	0.15	.883	.459	2.475
Financial activity	.91	.605	-0.14	.888	.247	3.352
Health	4.701**	3.242	2.24	.025	1.217	18.166
Information and communi-cation	1.534	1.5	0.44	.662	.225	10.434
Manufacturing	1.795	.866	1.21	.225	.697	4.62
Other services	5.617**	4.799	2.02	.043	1.052	29.979
Retail or Wholesale	1.157	.552	0.31	.76	.454	2.947
Occupation						
Clerks/service workers	.6*	.179	-1.71	.087	.335	1.077
Manager/professional	.586	.257	-1.22	.223	.248	1.385
Technicians/associate pro-fessionals	.462**	.179	-1.99	.047	.216	.989
Lay-off without payment						
Not Mentioned	2.266***	.589	3.15	.002	1.361	3.772
Work from home						
Yes	1.156	.345	0.49	.627	.644	2.075
Changing Hours						
Decreased by 1-25%	.802	.422	-0.42	.675	.286	2.249
Decreased by more than 25%	.74	.407	-0.55	.584	.252	2.172
Increased by more than 25%	.74	.568	-0.39	.694	.164	3.332
Stayed the same	3.608***	1.762	2.63	.009	1.386	9.394
Sigma-2 U	.054	.418				
LR test vs. ologit model: chibar2(01) = 0.02 Prob >= chibar2 = 0.4478 No. of obs=651						

Note: *** p<.01, ** p<.05, * p<.1. Reference Categories: (Changing hours: Increased 1-25%, Wage Delay: Mentioned, Occupation Type in February: Blue Collars, Sector type Feb: Accommodation and food services, Layout without payment: Mentioned, Work_Home: No)

Source: Authors collected and processed from R-software V. 4.4.2

2.1.2 Determinants of Covid-induced income changes in Jordan

Table 2 indicates the results of the proportional odds model. The model results showed a significant result in wage delay. The odds of being beyond any category of wage change in case of not having a wage delay was 0.2 the odds in case of mentioning a wage delay (p-value <0.01). The working stability was significant, and the odds of being in higher categories of wages (comparable to lower categories) were three times the odds in the irregular jobs. Social insurance, and the ability to work from home, didn't show a significant result. The changing hours showed a significant result in the category that stayed the same; the odds of being in higher categories of wage if the working hours stayed the same is four times the odds in case of the increased working hours (1-25%). The likelihood ratio test that compares the random effect model with the proportional odds model without random effect appeared to be significant (P-Value <0. 01), and the variance of the individual effect is 1.48.

Table 2. Factors affecting wage change using random effect ordered logistic model in Jordan

Wage Change	*OR*	*St.Err.*	*t-value*	*p-value*	*[95% Conf Interval]*	
Wage delay						
Not mentioned	.235***	.087	-3.93	0	.114	.484
Work Stability						
Regular	2.922***	1.012	3.10	.002	1.482	5.761
Social Insurance						
Yes	1.035	.359	0.10	.921	.524	2.042
Work from home						
Yes	1.043	.377	0.12	.907	.514	2.118
Changing Hours						
Decreased by 1-25%	.692	.417	-0.61	.542	.212	2.257
Decreased by more than 25%	.544	.347	-0.96	.339	.156	1.897
Increased by more than 25%	2.43	2.39	0.90	.367	.353	16.707
Stayed the same	4.217***	2.11	2.88	.004	1.581	11.245
Sigma-2 U	1.483	1.182				
LR test vs. ologit model: chibar2(01) = 2.63 Prob >= chibar2 = 0.0525 No. of obs=788						
**** p<.01, ** p<.05, * p<.1*						

Note: Reference Categories:(Wage delay: Mentioned, Work stability: Irregular, Social insurance: No, Working from home: No, Changing hours: increased by 1-25%)
Source: Authors collected and processed from R-software V. 4.4.2

2.1.3 Determinants of Covid-induced income changes in Sudan

Table 3 shows that the wage delay was significant; the odds of being beyond any category of wage change in case of not mentioning the wage delay is 0.2 the odds in the reference category. Besides, the model shows a significant result in the case of not mentioning a lay-off without payment; in this case, the odds of being in higher wage categories were seven times the odds in the case of mentioning a lay-off without payment. The model doesn't show any significant results for the changing hours, the sector type, and the occupation type. The variance of the individual effect is 0.46, but the likelihood ratio test was insignificant in comparing the models with random and without random effect (P-Value = 0.4326). Accordingly, there is no evidence of the individual effect on the variation of the dependent variable.

Table 3. Factors affecting wage change using random effect ordered logistic model in Sudan

Wage Change	*OR*	*St.Err.*	*t-value*	*p-value*	*[95% Conf Interval]*	
Wage Delay						
Not mentioned	.109*	.141	-1.71	.088	.009	1.391
Economic activity						
Transportation, storage	.652	.809	-0.34	.73	.057	7.415
Construction or utilities	1.051	1.599	0.03	.974	.053	20.721
Manufacturing, retail	.423	.479	-0.76	.448	.046	3.892
Occupation						
Clerks/service workers	1.186	1.713	0.12	.906	.07	20.13
Manager/ professional	.934	1.341	-0.05	.962	.056	15.587
Technicians/associate professionals	7.384	15.141	0.98	.329	.133	41.776
Lay-off without payment						
Not Mentioned	7.227**	6.666	2.14	.032	1.185	44.072
Changing Hours						

Stayed the same	1.802	1.584	0.67	.503	.321	10.098
Sigma-2 U	.468	2.674				
LR test vs. ologit model: chibar2(01) = 0.03			Prob >= chibar2 = 0.4326 No of obs=142			

Note: *** p<.01, ** p<.05, * p<.1. Reference Categories:(Wage delay: Mentioned, Sector type: Education, accommodation and food services, Layoff without payment: Mentioned, changing hours: Changed, Occupation Type in February: Blue Collars). The observations were small in each category of the occupation sector, the following categories were combined: (1) Education, accommodation and food services, (2) Transportation, storage, agriculture, fishing or mining, (3) Construction or utilities, financial activities or real estate, health, and information and communication, (4) manufacturing, retail or wholesale, and other services. Moreover, we added the categories of the change in the working hours together (increase or decrease) in one category, and the second category stayed the same.
Source: Authors collected and processed from R-software V. 4.4.2

2.1.4 Determinants of Covid-induced income changes in Morocco

Table 4 shows the odds of being in higher categories of wage change (versus lower categories) relative to the odds of the reference category. The wage delay variable was significant; it indicates that if there was no wage delay, the odds of being in high categories of wage were lower than the odds of the high categories in case of having a wage delay by 96%. The odds of high wages were 12 times higher in the clerks' categories than in the blue-collar category, and the rest of the categories didn't show any significance. The business status category (open with the same business hours) was significant, indicating that the odds of positive change in wages were 14 times the same odd in the reference category (chose to reduce the business hours). The variables such as the ability to work from home, social insurance, changing hours, and work stability didn't show any significance, and the variance of the individual effect was 1.16. The last row in the Table shows the number of observations (245). The likelihood ratio test result showed that the model with individual and without individual effect didn't show any significant difference, and the variables were enough to explain the variation in the dependent variable.

Table 4. Factors affecting wage change using random effect ordered logistic model in Morocco.

Wage change	*OR*	*St.Err.*	*t-value*	*p-value*	*[95% Conf Interval]*	
Wage Delay						
Not mentioned	.034***	.034	-3.41	.001	.005	.238
Occupation						
Clerks/service workers	12.327**	13.744	2.25	.024	1.386	19.621
Manager/professional	1.802	2.633	0.40	.687	.103	31.599
Technicians/ associate professionals	2.496	2.095	1.09	.276	.482	12.929
Work from home						
Yes	2.784	3.128	0.91	.362	.308	25.167
Work stability						
Regular	2.375	1.631	1.26	.208	.618	9.128
Social insurance						
Yes	3.27	2.674	1.45	.147	.659	16.242
Changing Hours						
Stayed the same	1.253	1.005	0.28	.779	.26	6.037
Business Status						
open but reduction in hours government mandate	6.003	7.36	1.46	.144	.543	66.384
open with the same business hours	13.95**	16.439	2.24	.025	1.385	14.486
Other	6.466	9.072	1.33	.183	.413	10.124
Sigma-2 U	1.162	2.089				
LR test vs. ologit model: chibar2(01) = 0.60			Prob >= chibar2 = 0.2197		Number of obs=245	

Note: **** p<.01, ** p<.05, * p<.1.* some categories of business status were combined because of a very small number of observations in some categories. Reference Categories:(Business Status: Chose to reduce the number of business hours, Social Insurance: No, changing hours: Changed, Work Stability: Irregular, Wage Delay: Mentioned, Occupation Type in February: Blue Collars).

Source: Authors collected and processed from R-software V. 4.4.2

2.1.5 Determinants of Covid-induced income changes in Tunisia

The background characteristics didn't show any significant difference when using the likelihood ratio test except for Tunisia; we added only the education because it was significant. Table 5 shows the odds of being in higher categories of wage change (versus lower categories) compared to the odds of the reference category. The category (less than basic education) was significant; the odds of being in high wages (comparable to lower wages) for workers with less than basic education was 44% lower than the same odds of basic education (P-value<0.1). The wage delay variable was significant; it indicates that if the wage delay was not mentioned, the odds of being in high categories of wage are lower than the odds of the high categories in case of a wage delay by 49%.

Regarding the effect of the sector type in February, the odds of high wages were around (3, 4, and 6) times higher in the categories of education and health, agriculture, and other services, respectively, than the odds in the accommodation and food services category. The rest of the categories didn't show any significance. If there was no lay-off without payment, the odds of being in positive change in wage were two times the odds of having a lay-off without payment. The business status category (open with the same business hours) was significant, indicating that the odds of positive change in wages were two times the same odd in the reference category (chose to reduce the business hours). Regular work status increases the odds of being in higher categories of wage change by 2.5 the odds of being in an irregular job. As for the working hours, if they were the same, the odds of being high wages were four times the odds in case of increasing working hours from 1-25%. The variables such as the ability to work from home, social insurance, and occupation type didn't show any significance, and the variance of the individual effect was 1.2. The last row in the Table shows the number of observations (1519). The likelihood ratio test result showed that the model with individual and without individual effect showed a significant difference, and the individual effect should be added to explain the variation in the dependent variable.

Table 5. Factors affecting wage change using random effect ordered logistic model in Tunisia

Wage Change	*OR*	*St.Err.*	*t-value*	*p-value*	*[95% Conf Interval]*	
Education						
Less than basic	.561*	.173	-1.88	.061	.306	1.027
Secondary	.833	.242	-0.63	.529	.472	1.471
Higher education	1.455	.562	0.97	.331	.683	3.101
Wage delay						
Not mentioned	.517***	.105	-3.24	.001	.347	.771
Work from Home						
Yes	.768	.246	-0.82	.41	.411	1.438
Economic activity						
Education	2.558*	1.341	1.79	.073	.916	7.147
Transportation and storage	1.638	.746	1.08	.278	.671	3.997
Agriculture, fishing, or mining	3.852***	1.852	2.80	.005	1.501	9.886
Construction or utilities	2.641**	1.142	2.25	.025	1.132	6.165
Financial activities or real estate	2.933	2.138	1.48	.14	.703	12.243
Health	3.358*	2.281	1.78	.075	.887	12.717
Information and communication	1.209	.829	0.28	.782	.315	4.638
Manufacturing	1.404	.556	0.86	.391	.646	3.049
Other services	5.988***	3.142	3.41	.001	2.141	16.747
Retail or Wholesale	1.341	.604	0.65	.515	.554	3.241
Occupation						
Clerks/service workers	1.112	.387	0.30	.761	.562	2.198
Manager/professional	1.019	.364	0.05	.959	.506	2.051
Technicians/ associate professionals	1.02	.342	0.06	.954	.528	1.969
Lay-off without Payment						

Not Mentioned	2.105***	.455	3.45	.001	1.379	3.215
Business Status						
open but reduction in hours_government mandate	.998	.335	-0.01	.995	.516	1.928
open with the same business hours	2.015**	.649	2.18	.029	1.073	3.787
Chose to temporarily close due to challenges	2.044	1.211	1.21	.228	.64	6.527
Don't know	.628	.374	-0.78	.435	.195	2.02
Temporarily closed due to government	1.841	1.055	1.06	.287	.599	5.663
Temporarily or permanently unrelated to the COVID-19	1.163	.6	0.29	.769	.423	3.196
Work Stability						
Regular	2.478***	.555	4.05	0	1.597	3.845
Social Insurance						
Yes	1.413	.317	1.54	.123	.91	2.192
Changing Hours						
Decreased by 1-25%	.562	.224	-1.44	.148	.257	1.228
Decreased by more than 25%	.778	.338	-0.58	.562	.332	1.821
Increased by more than 25%	1.122	.707	0.18	.855	.327	3.857
Stayed the same	3.836***	1.42	3.63	0	1.857	7.924
Sigma-2 U	1.192	.474				
LR test vs. ologit model: chibar2(01) = 12.38			Prob >= chibar2 = 0.0002		Number of obs=1519	

Note: *** p<0.01, ** p<0.05, * p<0.1. We combined two categories of business status due to small observations (permanently closed due to COVID19 outbreak and do not know) were combined because of a very small number of observations in some categories. Reference Categories: (Educ: Basic, Business Status: Chose to reduce the number of business hours, Social Insurance: No, changing hours: Increased 1-25%, Work Stability: Irregular, Wage Delay: Mentioned, Occupation Type in February: Blue Collars, Sector type Feb: Accommodation and food services, Layout without payment: Mentioned).
Source: Authors collected and processed from R-software V. 4.4.2

3. DISCUSSION

Work arrangements during the pandemic induced income changes. Workers who report delayed wages are likely among those who experienced increased incomes during the pandemic in Egypt, Jordan, Sudan, Morocco, and Tunisia. Experiencing a decrease in working hours and permanent lay-off contributed significantly to negative income changes. In Egypt, Jordan and Tunisia, the odds of being in categories of positive wage changes are higher for workers whose working hours stayed the same during the pandemic. Moreover, workers in the business, which is still open with the same working hours, are more experience with positive changes in wages in Tunisia. Permanently laid-off workers were also vulnerable to negative changes in incomes in Egypt, Tunisia, and Sudan. Work stability protected workers against income reductions in Jordan.

COVID-19 hit certain industries with its lockdown measures (International Labour Organization, 2020). Business characteristics such as its activity and size could explain differences across wage groups (Cajner et al., 2020). Workers in the food and accommodation sector experienced negative income changes, in contrast to workers in the education and health sectors, who were more likely to experience income increases in Egypt and Tunisia. Workers in the health sector were expected to be less affected due to the intense pressure on health facilities during the pandemic outbreak and those working in educational activities due to the transition to online teaching during the pandemic.

The impact of COVID-19 on wage workers varied according to work characteristics. Wage workers in the private sector, those working irregularly without social insurance and outside establishments were the most affected by the pandemic; they mentioned higher incidence rates of layoffs, decrease in incomes, or delays in wage payments. However, the effect of work characteristics differed across countries. Blue-collar, skilled agricultural, or production and transport showed a higher chance of experiencing income reduction in Egypt and Morocco. Engaging in regular work was negatively corrected with the experience of wage

reduction in Tunisia. While work stability, social insurance, economic activity, and occupation were not significant drivers of income changes in Jordan and Sudan.

Other studies found that sociodemographic characteristics significantly correlated with income changes during the pandemic. Younger workers were more likely to lose jobs and suffer income reduction during the COVID-19 outbreak, see Adams-Prassl et al. (2020), Blundell et al. (2020), and Montenovo et al. (2020). High-educated workers were more likely to maintain their incomes during the pandemic, in contrast to less-educated workers who have faced significant disruption in labour market outcomes. Piyapromdee and Spittal (2020) found that less-educated workers faced inadequate and inflexible working conditions, inability to work from home (location inflexibility), low demand for their industries, high lay-off rates, and low wages. In comparison, Adams-Prassl et al. (2020) found that younger workers and those with a university degree were more likely to suffer a drop in their incomes. Studies have also shown that females face high rates of unemployment and have reached their peak during the pandemic (Mamgain, 2021) and were more likely to experience a decrease in their incomes (Cajner et al., 2020; Adams-Prassl et al. (2020). However, the sociodemographic characteristics didn't show any significant difference in explaining income changes in Arab countries.

Working from home is one of the most notable features of the pandemic. Working from home was more concentrated among highly educated, high-paid workers (Blundell et al., 2020). Mongey et al. (2020) found that workers in jobs that cannot be completed from home or require physical proximity are more economically vulnerable, low-wage, low-education workers. There are notable differences in the inability to work from home across occupations and industries. A large proportion of jobs in developed countries can be done completely at home without a significant drop in earnings (Montenovo et al., 2020; Dingel and Neiman, 2020, Mongey and Weinberg, 2020). Workers in occupations related to information work and management were allowed to work remotely from home and other professions that could be performed remotely. Conversely, the largest share of jobs in lower-income economies cannot be performed at home (Dingel and Neiman, 2020). Our study found that the worker's ability to work from home didn't shape their income changes during the pandemic.

Although most Arab countries have unemployment insurance systems, they target limited groups of workers. Developing unemployment protection systems that ensure workers against unemployment and negative income changes prepares countries to face such crises. Expanding the scope of emergency social protection measures to protect financially vulnerable workers, especially workers in the affected sectors who experience permanent job loss and working hours reduction, represents a significant opportunity to develop a more comprehensive social protection system.

CONCLUSIONS

Introducing empirical findings that quantify the extent to of COVID-19 has impacted on the workers' economic status and signifies the key factors responsible for income changes is a useful tool for recovery efforts and designing policy responses. Work arrangements during the crisis have captured the emerging changes in workers' incomes. Workers who lost their jobs or worked fewer hours have experienced a substantial drop in their incomes. The economic effects of the pandemic have disproportionately affected workers across different countries. Work stability explained the differences in income changes between Jordanian workers partially. Food and accommodation workers suffered larger income declines than workers in other industries in Egypt and Tunisia. Blue-collar, skilled agricultural or production and transport showed a higher chance of experiencing income reduction than other workers in Egypt and Morocco. Regular work status increases the odds of experiencing positive income changes in Tunisia. It is imperative to expand the existing social protection systems in Arab counties to support those vulnerable workers.

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APPENDIX

Table A1. Variables' descriptions and categories

Main categories	*Variable description*	*Categories*
Background characteristics	Sex	1= Male 2= Female
	Age (in years)	Age (in five-year age groups)
	Highest level of education completed	1= Less than basic 2= Basic 3= Secondary 4= Higher education
	Marital status	1= Never Married 2= Currently Married 3= Widowed/divorced
	Place of residence	1= urban 2= rural
Work type	The main job/activity as of the end of February 2020	1= Farmer (owns a farm/self-employed on a farm) 2= Business owner/self-employed (but not a farmer) 3= Unpaid family worker on a farm 4= Unpaid family worker (but not a farmer) 5= Wage worker for Government / public sector 6= Wage Worker for a private sector /NGO 7= Unemployed and looking for work 8= Housewife 9= Full Time Student 10= Retired 11= Other, not employed and not looking for work (e.g. taking care of family members)
	The main job/activity in the past month	1= Farmer (owns a farm/self-employed on a farm) 2= Business owner/self-employed (but not a farmer) 3= Unpaid family worker on a farm 4= Unpaid family worker (but not a farmer)

		5= Wage worker for Government / public sector 6= Wage Worker for a private sector /NGO 7= Unemployed and looking for work 8= Housewife 9= Full Time Student 10= Retired 11= Other, not employed and not looking for work (e.g. taking care of family members).
	Economic activity (Feb. 2020)	Categorical 1= Agriculture, fishing or mining 2= Manufacturing 3= construction or utilities 4= Retail or Wholesale 5= Transportation and storage 6= Accommodation and food services 7= Information and communication 8= Financial activities or real estate 9= Education 10= Health 11= Other services
	Economic activity (Last Month)	Categorical 1= Agriculture, fishing or mining 2= Manufacturing 3= construction or utilities 4= Retail or Wholesale 5= Transportation and storage 6= Accommodation and food services 7= Information and communication 8= Financial activities or real estate 9= Education 10= Health 11= Other services
	Occupation (Feb. 2020)	1= Manager/professional 2= Technicians/associate professionals 3= Clerks/service workers 4= Blue collar, skilled agricultural, production and transport
	Occupation (Last Month)	1= Manager/professional 2= Technicians/associate professionals 3= Clerks/service workers 4= Blue collar, skilled agricultural, production and transport
Work characteristics	Employment stability (Feb. 2020)	1= Regular (permanent or temporary) 2= Irregular (causal, seasonal, or intermittent)
	Social insurance (Feb. 2020)	1 (Yes), 2 (No)
	Work inside establishment (Feb. 2020)	1 (Yes), 2 (No)

Work arrangements	Status of business worked for (Feb. 2020)	1= Temporarily closed due to government mandate related to the COVID-19 outbreak 2= Chose to temporarily close due to other challenges related to the COVID-19 outbreak 3= Temporarily or permanently closed due to factors unrelated to the COVID-19 outbreak 4= Permanently closed due to challenges related to the COVID-19 outbreak 5= open with the same business hours 6= open but reduction in business hours due to government mandate related to the COVID-19 outbreak 7= Business chose to reduce number of business hours 8= Do not know
	Past 60 days: temp. layoff/suspension (without pay)	0= Not mentioned 1= Mentioned
	Past 60 days: permanent layoff/suspension	0= Not mentioned 1= Mentioned
	Past 60 days: changed hours	1= Decreased by more than 25% 2= Decreased by 1-25% 3= Stay the same 4= Increased by 1-25% 5= Increased by more than 25%
	Past 60 days: delay in wage payment	0= Not mentioned 1= Mentioned
	Ability to work from home	1 (Yes), 2 (No)
	The reason for inability to work from home	1= Not allowed 2= Lack technology 3= Lack internet connection 4= Caregiving responsibilities 5= Not possible to do job off work site 6= Other (specify)
The dependent variable	Changed pay	1= Decreased by more than 25% 2= Decreased by 1-25% 3= Stay the same 4= Increased by 1-25% 5= Increased by more than 25%

Source: own

Table A2. The number of observations by waves and the total number of rounds

Observations by completed number of rounds					
Waves	*1*	*2*	*3*	*4*	*Total*
1	3773	590	261	1306	5930
2	2957	2384	1981	1306	8628
3	2677	1585	994	1306	6562
4	2726	2773	1720	1306	6562
5	2599	988	987		4574

Source: own

Table A3. The number of observations by country, waves, and the maximum number of rounds.

Country	*Waves*	*Maximum number of rounds*	*Number of observations*
Egypt	1,2,4	2	883
Sudan	3,5	2	452
Morocco	1,2,3,4	4	314
Tunisia	1,2,3,4	4	992
Jordan	2,4,5	3	982

Source: own

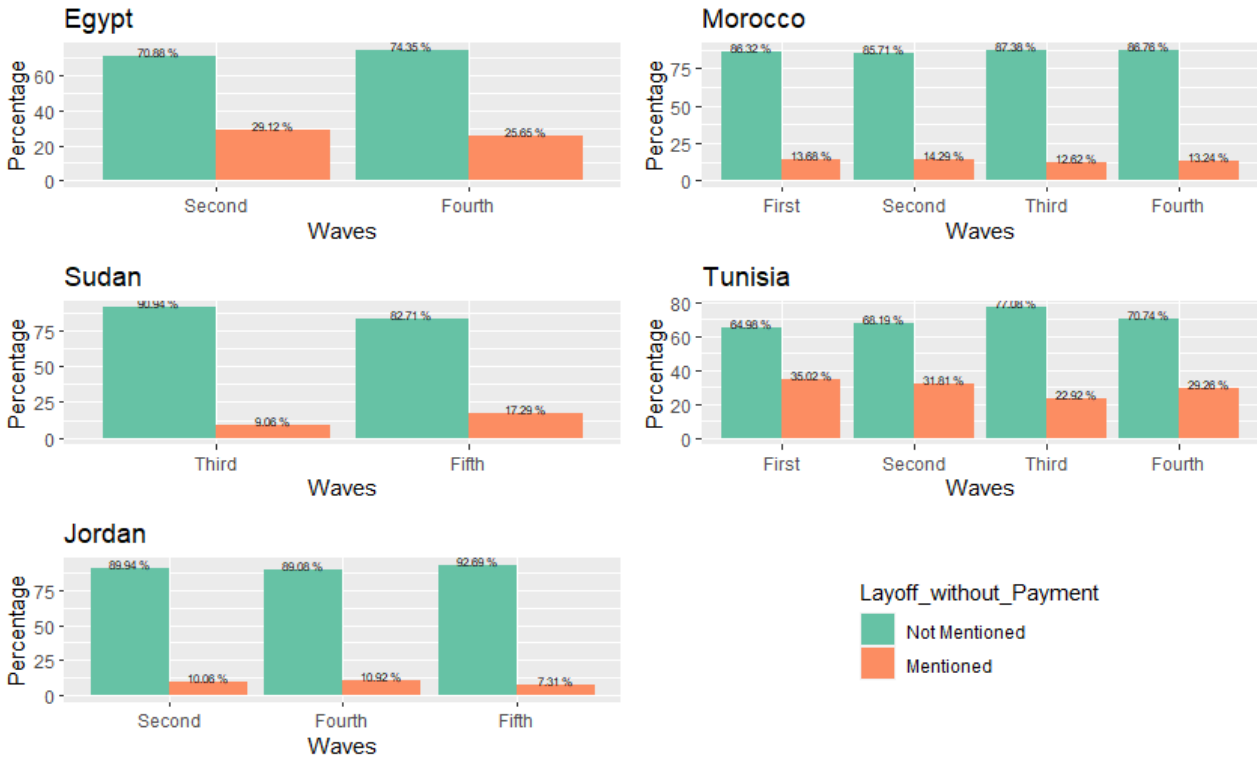

Figure A1. The distribution of the sample members according to the waves and the presence of the temporary layoff without payment in the five selected countries
Source: own

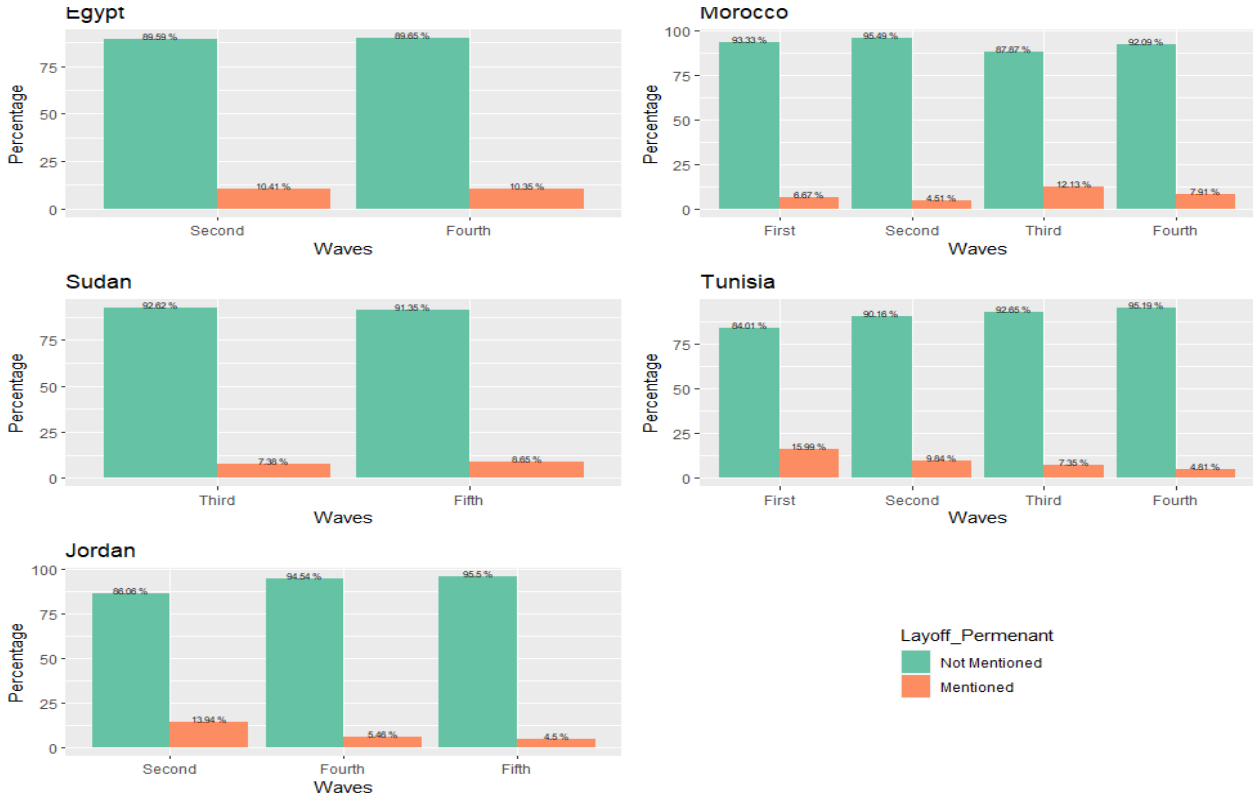

Figure A2. The distribution of the sample members according to the waves and the existence of permanent layoffs in the five selected countries
Source: own

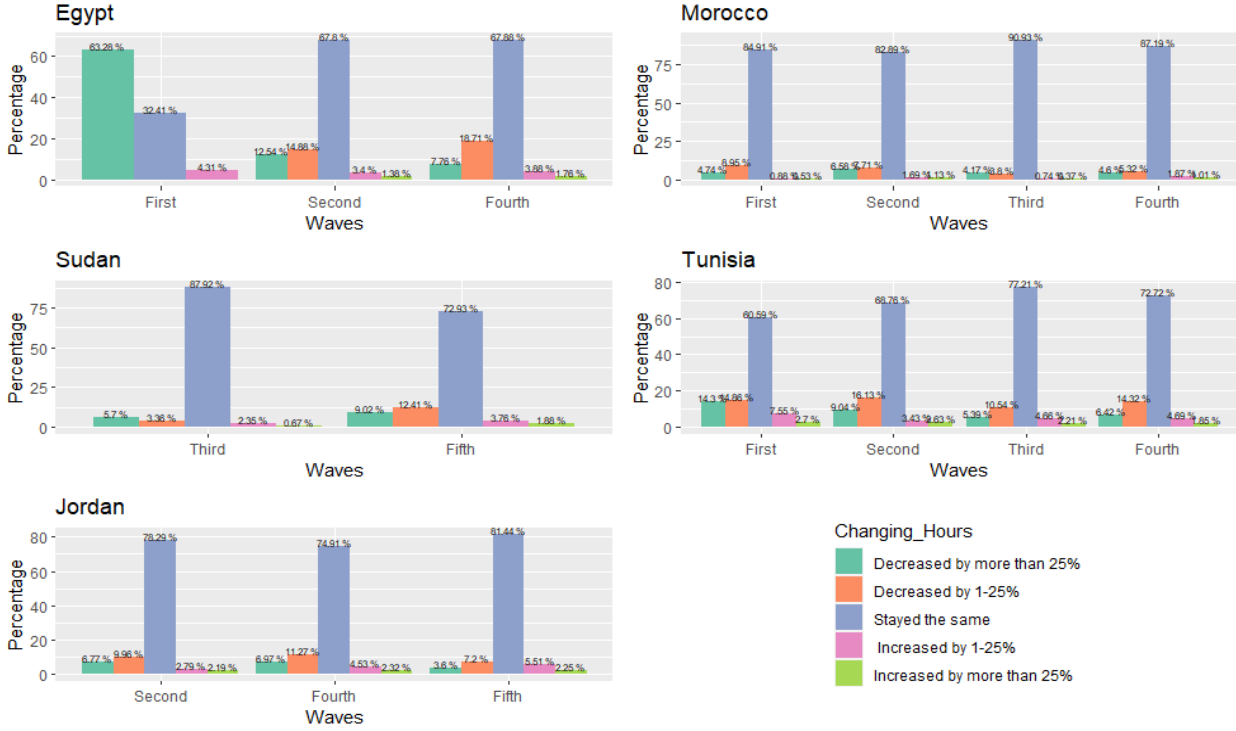

Figure A3. The distribution of the sample members according to the waves and the working hours during the pandemic in the five countries
Source: own

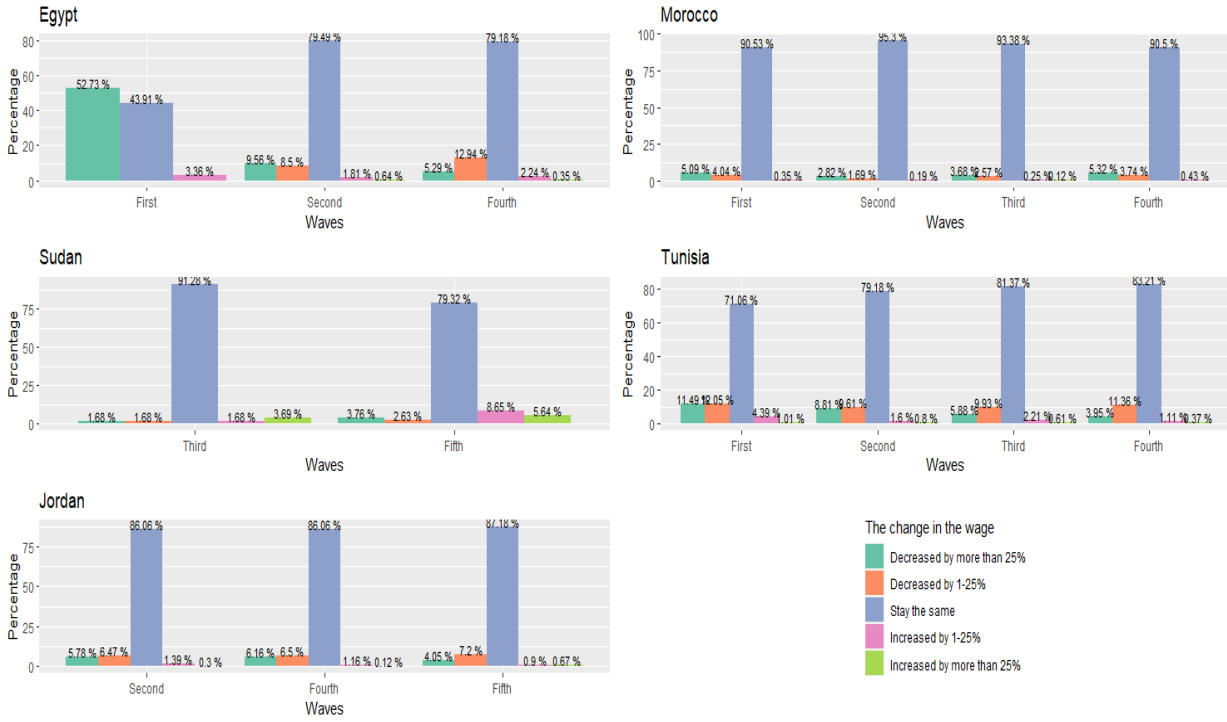

Figure A4. The distribution of the sample members according to waves and the percentage of the change in the wage in the five selected countries
Source: own

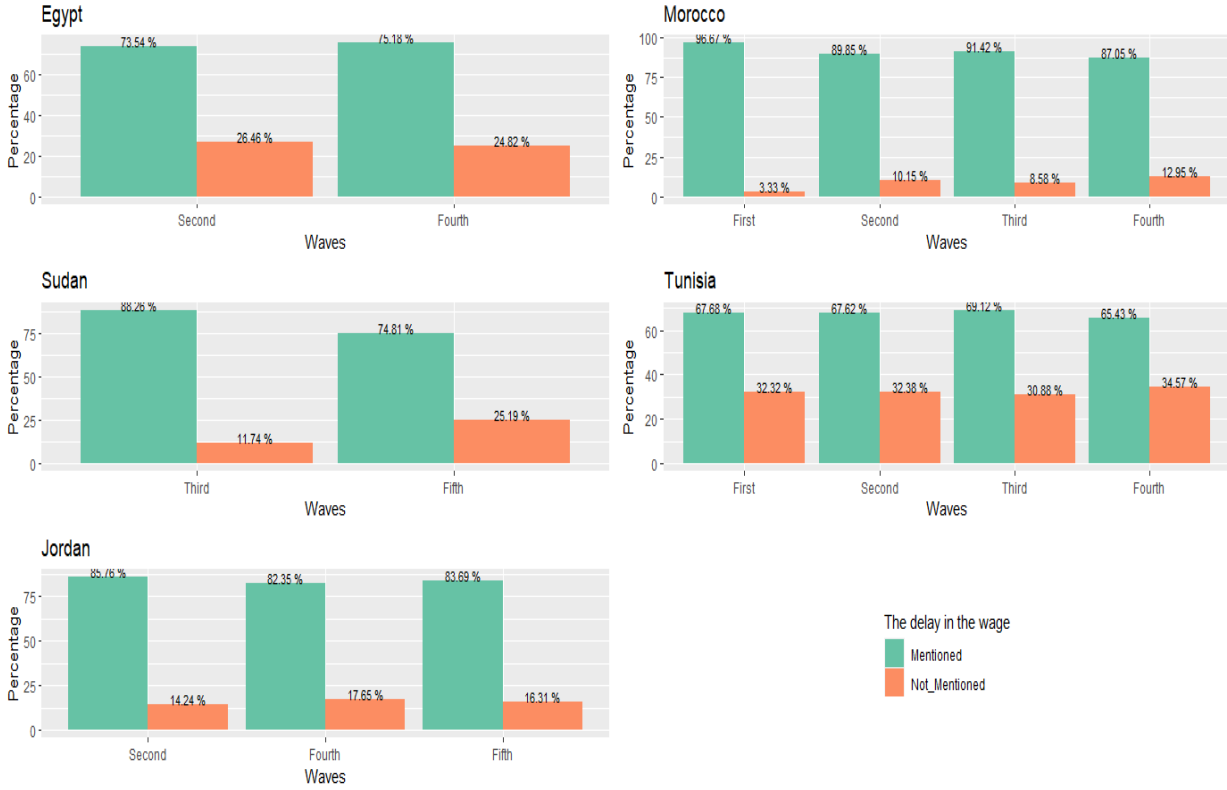

Figure A5. The distribution of the sample members according to the waves and the delay in wage during pandemic in the five selected countries
Source: own

Figure A6. The distribution of the sample members according to the waves and the ability to work from home in the selected countries
Source: own

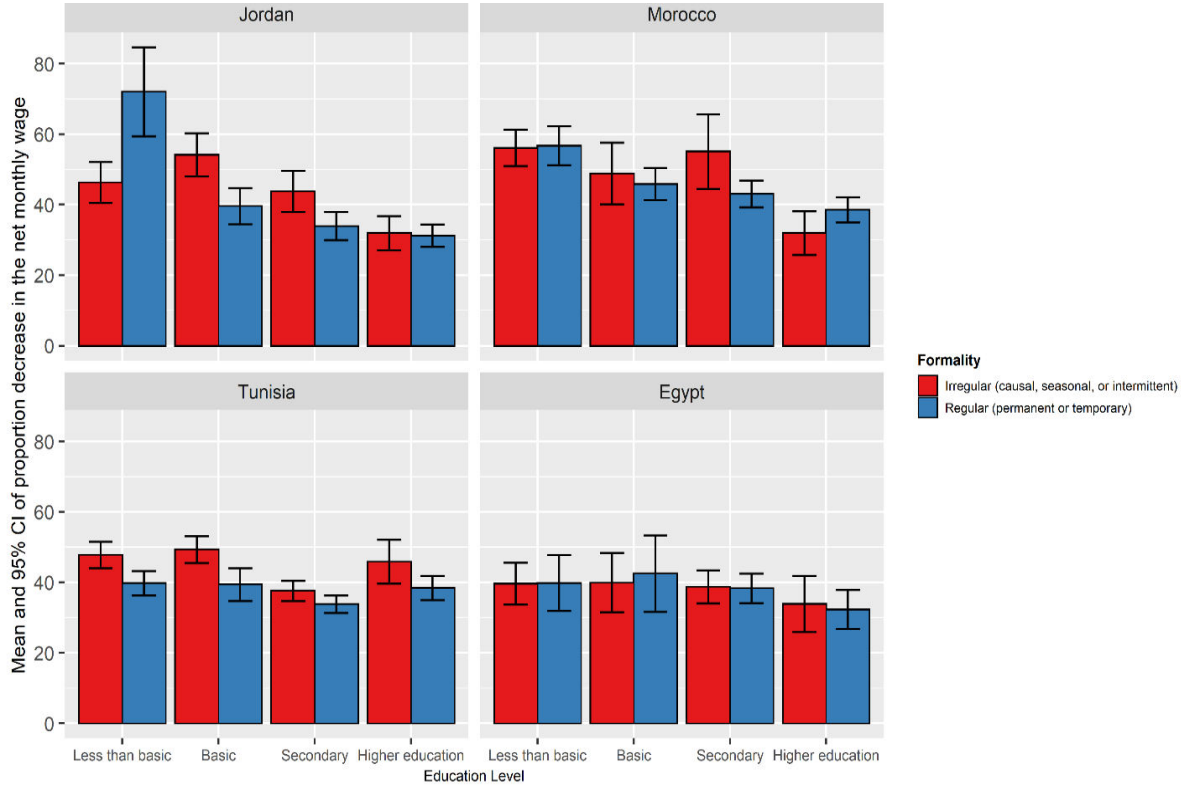

Figure A7. Mean and 95% of proportion decrease in the monthly wage by education level in Arab countries
Source: own