Determinants and performances of food security in the Middle East and North Africa region countries

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Abstract

The current food security situation in the Middle East and North Africa (MENA) region is surrounded by uncertainty and bleak due to several domestic and global challenges, such as a rapid increase in population growth rate, a global slowdown in economic growth rate, climate change impacts, a reduction in water resources, the spreading of political instability, the prevalence of malnutrition, low food production, high food import dependency, weak transport infrastructure, weak drinking water and sanitation services, and suffering from a severe income gap between the population of this region. This paper aims to shed light on the food security situation in the MENA region by investigating the determinants of food security in that region and then measuring the food security performance of each MENA country. The study contributes to tackling the current food security situation in the MENA region by focusing on investigating the food security determinants and weights by using multiple regression analysis to understand the role of macroeconomic factors in improving food security performance in the MENA countries. The findings confirm that in terms of food availability and access, the MENA countries have decent stability on those dimensions, while food utilization and stability dimensions in MENA countries have poor performance.

Keywords*: Food Security, MENA, Multiple Regression Analysis, Food Security Determinants and performance.*

1. Introduction

Food security is a relatively recent concept, and the origins of this term go back to the conference held by the United Nations in 1943 at Hot Springs, Virginia, stating that "a secure, adequate, and suitable supply of food should be a cardinal aim in every country" (Clapp, 2022). This term developed in the 1980s when the international community realized that the progress of any country depends on its ability to achieve minimum levels of self-sufficiency, which gave birth to the concept of "food for development" (Sassi, 2018). In 1974, for the first time, food security was formally defined at the World Food Conference as: "the availability at all times of adequate world food supplies of basic foodstuffs, particularly so as to avoid acute food shortages in the event of widespread crop failure, natural or other disasters, to sustain a steady expansion of food consumption in countries with low levels of per capita intake, and to offset fluctuations in production and prices" (United Nations, 1974).

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The term "food security" was updated in 1996 at the World Food Summit in Rome, in which the food security dimensions were included in this new definition, stating: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996).

The definition of food security in 1996 sheds light on four dimensions of food security, which are as follows: The first dimension is "food availability", which means the necessity of providing food in quantities sufficient for the number of individuals in a country or region. It includes the amount of food available through all forms of local production, imports, food stocks, and food aid. The second dimension is "economic and physical access to food", which means "An adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives". The third dimension is "food utilization", which means ensuring the health, safety, and suitability of food for human consumption, or food that is safe and nutritious and meets the nutritional needs of humans. The fourth dimension is "food stability", which means the necessity of maintaining food conditions and the necessity of the three previous dimensions being present with each other without any change occurring to them.

In this context, the Middle East and North Africa (MENA) region faces many internal and external challenges that affect its levels of food security. The first challenge lies in the rates of population increase, as this region is considered one of the most densely populated regions in the world, as the population in that region represents about 6% of the world's population, with an expected increase in the population number of up to 700 million people in the year 2050 (World Population Review, 2022). The second challenge facing this region, which is no less dangerous than the first challenge, is climate change, as it increases temperatures and decreases rainfall, which affects local agriculture, which is the main source of food supply to the population (about 50% of the total food supply), in addition to the fact that most of these areas live under conditions of water stress, which may lead to conflicts and disputes over land and water resources in the future (Belhaj, 2021). The third challenge is diet and nutrition, as the population of that region depends on wheat and other basic grains as a main source of food, and half of the quantities consumed of this food are imported from countries outside the region and what makes matters worse for the food security situation in the MENA region is the Russian-Ukrainian war. This war affected the food supply of wheat and basic grains for that region (Kandeel, 2022).

According to the United Nations International Children's Emergency Fund, the MENA region includes 20 countries, which are: Algeria, Bahrain, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, the State of Palestine, Sudan, the Syrian Arab Republic, Tunisia, the United Arab Emirates, and Yemen (UNICEF, 2021). Despite these countries sharing common challenges and cultural links, MENA countries can be classified into three groups based on their income level: (1) high-income countries like Qatar, the United Arab Emirates, Kuwait, Bahrain, Saudi Arabia, and Oman; (2) middle-income countries like Algeria, Tunisia, Jordan, Egypt, Libya and Morocco; and (3) low-income countries like the Palestine, Sudan, Syria, and Yemen. The phenomenon of climate change in African countries is expected to increase conflicts and socio-economic inequalities and jeopardize the continent (Mulazzani *et al*., 2020), in which rising temperatures and decreasing water resources will continue to accelerate the shrinking arable land and desertification rate in the MENA region. Desertification has negative effects on ecosystem dynamics, human health, air quality, land productivity, and conflict risks. In terms of food security, agriculture is a key sector for both social and economic development and plays a vital role in most MENA countries national economies, but agriculture is considered the largest water-consuming sector in the Middle East, which makes it the most vulnerable sector to climate change effects. Climate change has a negative impact on agri-

culture due to rising temperatures and declining rainfall, leading to a decline in crop productivity and yields, rising food prices, and spreading child malnutrition. Therefore, climate change is set to significantly decrease food security levels, and it will contribute to more conflicts and political unrest in the region.

The governments of MENA countries were pushed to rethink their development models due to the domestic challenges mentioned before, along with a rapid change in the global environment. The traditional development model for the net oil exporters in the MENA region has relied on oil wealth, state preference over markets, and import substitution industrialization. On the other hand, the conventional development model for the non-oil countries in the MENA region, particularly these countries that are around the Mediterranean Sea, has relied on agriculture, which plays a vital role for their economies, but it cannot be sufficient for the macro-level food security to meet the population needs of these countries (Abis & Demurtas, 2023). Moreover, the new development models for both the oil exports and non-oil exports countries in this region are facing complicated global and regional challenges such as the increasing severity of climate change, a decrease in food security levels, and increasing dependence on the international market. Therefore, it is not possible to apply a unified development model to improve food security performance in all MENA countries due to the diversity of resources available to them. But at the same time, it is possible to rely on a set of common indicators of food security for this region to capture the dimensions of food security at both the macroeconomic level and microeconomic level such as population growth rate, economic growth model, structural change, agriculture performance, oil role, poverty reduction, and climate change impacts (Breisinger, 2010).

This paper aims to shed light on the food security situation in the MENA region by investigating the determinants of food security in that region and then measuring the food security performance of each MENA country through a set of common food security indicators that reflect the four dimensions of food security. This paper contributes to expanding the understanding of the food security situation in the MENA region, as there are few previous studies in this regard. In addition, less attention has been given to the role of macroeconomic factors in improving the food security performance in that region. Therefore, the current paper will fill this research gap by answering the following two questions: (1) What are the determinants of food security in the MENA region? (2) What are the common food security indicators that can be used to measure the food security performance of the MENA countries? So, the paper will attempt to answer the first question via a literature review at regional and domestic levels to figure out the potential determinants of food security in the MENA region and countries. Then use multiple regression analysis to show weight of each determinate. After that, the author can answer the second question by estimating the current food security performances for each MENA country by combining the econometric techniques with indicator weights on each food security dimension on the global index and from principal component analysis (PCA). The data was collected from the Food and Agriculture Organization of the United Nations (FAO) and the World Bank (WB).

2. Literature Review

There are many previous studies that indicate a food security situation, especially in low-income countries around the world. But there are few studies indicating the food security situation in the countries of the MENA. In this context, at the regional level, a study like (Omidvar, 2019) aims to assess food security and socio-demographic factors in 18 MENA countries, which are: Lebanon, the United Arab Emirates, Kuwait, Saudi Arabia, Bahrain, Libya, Morocco, Pakistan, Jordan, Iran, Egypt, Tunisia, Afghanistan, Iraq, Yemen, Syria, Sudan, and Somalia. Results showed that the main determinants of food security are education, health, and income levels. (El-Mahmad and Amar, 2021) focused on the role of agriculture in food security in the MENA region. The selected MENA countries for this study are Qatar, Bahrain, the United Arab Emirates, Kuwait, Oman, Saudi Arabia, Jordan, Algeria, Lebanon, Egypt, Morocco, and

Tunisia. Results showed that the main determinants of food security are not only agricultural factors but also macroeconomic factors that play an important role in food security performance in the MENA region, such as global food prices, trade openness, and the main sector of the country (agriculture or oil sector).

Additionally, a study by (Fathelrahman, 2016) focuses on the food policy in the MENA region, which is associated with food security. The study includes 17 countries, which are: Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, the United Arab Emirates, and Yemen. Results showed that the main determinants of food security in the MENA region are food supply, food distribution, food processing, price stability, and households' income. Moreover, (Zolfaghari, 2021) investigates the role of economic, institutional, and climatic indexes associated with food security in the MENA region countries, such as Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates, Malta, Iran, Iraq, Jordan, Lebanon, Syria, the West Bank and Gaza Strip, Yemen, Algeria, Djibouti, Egypt, Libya, Morocco, and Tunisia. Results showed that the main determinants of food security are political stability, economic growth, price inflation, and civil conflicts. In addition, (Koç, 2017) conducted a study that aimed to analyze the determinants of the food insecurity by examining the relationship between important (economic, social, and natural) factors and an overall food insecurity index that was derived by dividing the value of food imports by the sum of total exports and net remittance inflows. The study covers 18 MENA countries and Turkey. The MENA countries are as follows: Bahrain, Kuwait, Qatar, Oman, Saudi Arabia, the United Arab Emirates, Tunisia, Libya, Iran, Egypt, Jordan, Morocco, Syria, Yemen, Algeria, Lebanon, Sudan, and the West Bank and Gaza Strip. The findings of the study show that water resource availability, food prices, education, and population growth are the main socio-economic determinants of food security in the MENA region.

At the country level of the MENA region, there are many studies focusing on the determinants and/or performances of food security, particularly in middle- and low-income countries. Many studies have pointed out the food security situation in Egypt, such as Outhman, 2023; Mirgorod, 2023; Shi, 2022; Kamel, 2022; Ramadan, 2017 and Yassin, 2016. These studies investigate the major elements affecting food security on both sides (food demand and supply). The findings of these studies show that economic growth, agriculture role, poverty, population growth, education, food policy, food prices, and income are the main determinants of food security in Egypt. So, both agricultural and macroeconomic factors are affecting the food security performance in Egypt. In the same context, there are few studies focusing on the food security situation in Tunisia, such as Fares, 2023; Jeder, 2020; Chemingui, 2000 and Newman, 2018. These studies examine the main factors affecting food security. The results of these studies show that trade openness, global food prices, climate change, agri-food policies, water resources, and political stability are the main determinants of food security in Tunisia. Moreover, some recent studies examine the food security situation in Algeria. These studies identify the major elements affecting food security on both micro- and macro-levels, such as Touidjeni, 2022; Draou, 2022; Bouchentouf, 2021; Nnadozie, 2020 and Boudkhil, 2020. These papers conclude that the main determinants of food security in Algeria are the role of the oil and agriculture sectors, food prices, population growth, and education level. On the other hand, there are many studies that focus on the food security situation in high-income MENA countries.

Many studies have pointed out the food security situation in both Saudi Arabia and the United Arab Emirates. Both countries have a net oil export-based economy, so they have a different food security situation than middle-income countries like Egypt and Tunisia, which have an agriculture-based economy. Recent studies have pointed out the food security challenges in Saudi Arabia, such as Elneel, 2023; Alsarawi, 2023 and Rahman, 2019. The results show that food supply, inflation, population growth, water resources, the oil sector, climate change, and extension services are the major elements affecting the food security performance in Saudi Arabia. In addition, there are a few recent studies of the

food security situation in the United Arab Emirates, such as Ammar, 2023; Ali, 2022 and Manikas, 2022. These papers focus on the food security situation in the UAE by investigating the four dimensions of food security. The findings found that cereal imports, food prices, economic growth, water resources, the oil sector, climate change, and agri-food policy are the main determinants of food security in the UAE.

Based on this literature review, the author concluded that the major elements affecting food security and its dimensions in the MENA countries can be divided into two main factors, which are: sectoral factors (agricultural-based economies or oil-based economies) and macroeconomic factors (gross domestic product, inflation, trade openness, nutrition literacy, economic growth rate, political stability, etc.). In addition, a little attention has been given to macroeconomic factors and their indicators in order to measure the food security performance in the MENA.

3. Methodology

In this part of the paper, the author will describe the data characteristics, sources, and selected variables that have been taken into consideration to estimate an appropriate econometric model, which tackle the similarity and differences for specific characteristics between the MENA countries in order to measure the food security performances or scores for each MENA country in this study based on the data availability and limitations.

3.1. *Data Sources*

The data was collected from two main sources, which are the Food and Agriculture Organization of the United Nations (FAO) and the World Bank (WB). The main limitation of this study is that only secondary data has been used. Conducting a survey across the MENA region could have strengthened the study at the micro-level (microeconomic factors), but it was avoided due to the high financial cost required to gather accurate primary data. The data was collected for 13 MENA countries based on data availability, which are: Algeria, Egypt, Iraq, Jordan, Lebanon, Morocco, Oman, Sudan, Saudi Arabia, Sudan, Tunisia, the United Arab Emirates, and Yemen.

3.2. *Data Variables*

The approach of this paper that follows will be based on the suite of indicators presented in the State of Food Insecurity Report in 2013, in which each dimension of food security has five main indicators that can be combined and used to estimate the food security index/score, and they are as follows:

The food availability dimension includes five main indicators, which are: average dietary energy supply adequacy, average value of food production, share of dietary energy supply from cereals, average protein supply, and average supply of protein of animal origin. FAO or WB has defined those indicators as follows:

- *Minimum dietary energy supply requirements:* "The indicator expresses the Dietary Energy Supply (DES) as an amount of the minimum Dietary Energy Requirement (ADER). Each country's or region's minimum supply of calories for food consumption is normalized by the minimum dietary energy requirement estimated for its population to provide an index of adequacy of the food supply in terms of calories".
- *Food production index:* "Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value".
- *Dietary Energy Supply from cereals:* "The indicator expresses the energy supply (in kcal/caput/day) provided by cereals, roots and tubers from the total Dietary Energy Supply (DES) (in kcal/caput/day) calculated from the corresponding countries in the FAOSTAT food balance sheets".
- *Average protein supply:* "National average protein supply (expressed in grams per caput per day). This indicator provides information on the quality of the diet".
- *Average fat supply:* "National average fat supply (expressed in grams per caput per day). This indicator provides information on the quality of the diet".

The food access dimension includes four indicators, which are: rail lines density, domestic food price level index, prevalence of undernourishment, and gross domestic product per capita. FAO has defined those indicators as follows:

- *Rail lines density:* "Rail lines density corresponds to the ratio between the length of railway route available for train service, irrespective of the number of parallel tracks (rail lines, total route in km) with the area of the country, for example: rail lines density (per 100 square km of land area)".
- *Domestic food price level index:* "Food price index is a measure of the monthly change in international prices of a market basket of food commodities. It consists of the average of five commodity group price indices, weighted with the average export shares of each of the groups".
- *Prevalence of undernourishment:* "POU expresses the probability that a randomly selected individual from the population consumes a number of calories that is insufficient to cover her/his energy requirement for an active and healthy life. The indicator is computed by comparing a probability distribution of habitual daily dietary energy consumption with a threshold level called the minimum dietary energy Requirement. Both are based on the notion of an average individual in the reference population".
- *Gross domestic product per capita:* "GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products".

The food stability dimension includes six indicators, which are: cereal import dependency ratio, percent of arable land equipped for irrigation, value of food imports in total merchandise exports, political stability and absence of violence/terrorism, per capita food production variability, and Gini index. FAO has defined those indicators as follows:

- *Cereal import dependency ratio:* "The cereals import dependency ratio tells how much of the available domestic food supply of cereals has been imported and how much comes from the country's own production. It is computed as (cereals imports - cereals exports) / (cereals production + cereals imports - cereals exports) * 100. Given this formula the indicator assumes only values <= 100. Negative values indicate that the country is a net exporter of cereals. This indicator provides a measure of the dependence of a country or region from cereals imports. The greater the indicator, the higher the dependence".
- *Agricultural irrigated land (% of total agricultural land):* "Agricultural irrigated land refers to agricultural areas purposely provided with water, including land irrigated by controlled flooding".
- *Value of food imports in total merchandise exports:* "This indicator provides a measure of vulnerability and captures the adequacy of foreign exchange reserves to pay for food imports, which has implications for national food security depending on production and trade patterns".
- *Political stability and absence of violence/terrorism:* "Political stability and absence of violence measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

This indicator provides a measure of political shocks that might have implications for national food security".

- *Trade openness:* "Trade openness is one measure of the extent to which a country is engaged in the global trading system. Trade openness is usually measured by the ratio between the sum of exports and imports and gross domestic product (GDP)".
- *Gini index:* "Gini index measures the extent to which the distribution of income (or,

in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality, according to World Bank".

The food utilization dimension includes five main indicators, which are: percentage of people using at least basic drinking water services, percentage of people using at least basic sanitation services, percentage of children under 5 years of age affected by wasting, percentage of children under 5 years of age who are stunted, and percentage of children under 5 years of age who are underweight. FAO has defined those indicators as follows:

- *Percentage of people using safely managed basic drinking water services:* "drinking water services is defined as drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip. Improved water sources include piped water, boreholes or tubewells, protected dug wells, protected springs, and packaged or delivered water".
- *Percentage of people using safely managed sanitation services:* "The percentage of people using at least basic sanitation services, that is, improved sanitation facilities that are not shared with other households. This indicator encompasses both people using basic sanitation services as well as those using safely managed sanitation services. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, compositing toilets or pit latrines with slabs".
- *Percentage of children under 5 years of age who are underweight:* "Percentage of underweight (weight-for-height more than 2 standard deviations of the World Health Organization Child Growth Standards median) among children aged 0-5 months. According to (WHO)".
- *Percentage of children under 5 years of age affected by wasting:* "Wasting prevalence is the proportion of children under five whose weight for height is more than two standard deviations below the median for the international reference population ages 0-59 months.
- *Percentage of children under 5 years of age who are stunted:* "Percentage of stunting (height-for-age less than -2 standard deviations of the WHO Child Growth Standards median) among children aged 0-59 months. This indicator belongs to a set of indicators whose purpose is to measure nutritional imbalance and malnutrition resulting in undernutrition (assessed by underweight, stunting and wasting)".

So, author can summarize the food security variables that has been used as follows: minimum dietary energy supply requirement, food production index, dietary energy supply from cereals, average protein supply, average fat supply, rail lines density, food price index, prevalence of undernourishment, gross domestic product per capita, drinking water services, sanitation services, percentage of children under 5 years of age (who are stunted, affected by wasting, and who are underweight), cereal import dependency ratio, agricultural irrigated land, food imports, trade openness, and Gini index.

3.3. *Model Specification*

Descriptive and quantitative analysis will be used through simple regression and multiple regression, using the multiple regression method, to interpret the independent variables and determine the extent of their impact on the dependent variable and the extent of their compatibility with economic theory. However, there is one disadvantage of using multiple regression analysis in this case, which is the existence of poor-quality data, especially for food access and utilization dimensions, due to the absence of strong local institutions to collect accurate real data. The summary of food security indicator weights by FAO is presented in Table 1. So, to examine the determinants of food security in the MENA region, the author will conduct econometric methods for multiple regression analysis. Based on the conclusion of the literature review about the

potential determinants of food security, the general model can be expressed as follows:

$$Y_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \ldots\ldots + \alpha_p X_p + \varepsilon_i \quad (1)$$

In log terms the equation (1) becomes as follows:

$$Ln\ Y_i = \alpha_0 + \alpha_1 ln\ X_1 + \alpha_2 ln\ X_2 + \ldots\ldots + \alpha_p ln\ X_p + \varepsilon_i \quad (2)$$

Where

Y_i = Dependent variable

α_0…...α_p = Coefficient for the explanatory variables

X_1…...X_p = Independent variables

ε_i = Random error term

The empirical model can be written as following:

$$FSS = F(FAI, FCI, FUI, FSI) \quad (3)$$

In log terms the equation (3) becomes as follows:

$$\ln FSS = \alpha_0 + \alpha_1 ln\ FAI + \alpha_2 ln\ FCI + \alpha_3 ln\ FUI + \alpha_3 ln\ FSI + \varepsilon_i \quad (4)$$

Where

FSS = Food Security Score or performances

FAI = Food availability indicators (dietary energy supply, food production, protein …etc.).

FCI = Food access indicators (Rail lines density, POU, GDP per capita …etc.).

FUI = Food utilization indicators (drinking services, sanitation services, children stunting … etc.).

FSI = Food stability indicators (Cereal import dependency, political stability, Gini index … etc.).

Table 1 - Summary of food security indicator weights.

Food Security Indicator	*Food Security Dimension*	*Total Weight*	*PCA Weight*	*Global Weight*
Average Dietary Energy Supply (DES) Adequacy	Availability	0.25	0.18	0.04
Average Value of Food Production			0.17	0.04
Share of DES derived from cereals,			0.18	0.04
Average protein supply			0.24	0.06
Average supply of protein of animal origin			0.24	0.06
Percent of paved roads over total roads	Access	0.25	0.25	0.02
Road density			0.34	0.03
Rail-lines density			0.41	0.03
Domestic Food Price Level Index	Access	0.08	1	0.08
Prevalence of Undernourishment	Access	0.08	1	0.08
Water	Utilization	0.25	0.18	0.05
Sanitation			0.20	0.05
Stunting			0.22	0.06
Wasting			0.15	0.04
Underweight			0.24	0.06
Cereal import dependency	Stability-Exposure	0.125	0.40	0.05
Percentage of land equipped irrigation			0.32	0.04
food imports/total merch. exports			0.28	0.04
Political stability	Stability-Shock	0.125	0.28	0.04
Food supply variability			0.43	0.05
Domestic FPLI volatility			0.28	0.04

Source: AFCAS 23, 2013. FAO: New approaches to the measurement of food security.

4. Results and Discussion

In this section, the author investigates the food security situation by dividing the MENA countries into three main groups based on their income level (high-income level, middle-income level, and low-income level) (presented in Tables 3, 4, and 5). In addition, the author conducts a comparison between MENA countries in terms of each food security indicator. Then, the results of the multiple regression analysis for food security determinants in the MENA region are presented in Table 6. After that, the author measures the food security performance (score) for each MENA country and presents it in Table 7.

4.1. *Food Security in High Income MENA Countries*

Regarding the food availability dimension, the high-income countries of the MENA, such as the Emirates, Kuwait, Saudi Arabia, and Oman are considered countries that require a large amount of daily dietary energy supply, as the average food supply in the selected high-income MENA countries is 1926 kcal/day, while the global average is 1827 kcal/day. Wheat and major cereals represent the largest portion of the dietary energy supply (DES) for MENA countries, and the selected high-income MENA countries are not the exception, as the dietary energy supply from cereals represents about 43% of the total DES. The selected high-income MENA countries have a high protein consumption of 135 kcal/day compared to average global consumption of 89 kcal/day. In terms of the food access dimension, the rail line density is very low in the selected high-income MENA countries due to the small total area of those countries except Saudi Arabia. The selected high-income MENA countries have a low prevalence of undernourishment (% of population), except Oman, where the POU is 10% of the total population. GDP per capita in the selected high-income MENA countries is very high ($48,050) compared to the global GDP per capita ($18,381) since those countries are oil exported-based economies. In terms of the food utilization dimension in the selected high-income MENA countries, almost all the people are using safely managed drinking water and sanitation services, except Saudi Arabia, which suffers from some sort of unsafely managed sanitation service by 20% of the total population. About 22% of children under 5 years old suffer from stunting, being underweight, or being affected by wasting in the selected high-income MENA countries (a high malnutrition indicator). In terms of the food stability dimension, the average dependence of the selected high-income MENA countries on cereal imports is very high (91%). The selected high-income MENA countries are enjoying some sort of political stability, except Saudi Arabia, but those countries are suffering from a severe income gap between their populations based on the Gini index indicator. Therefore, those countries face a food instability shock (Table 2).

4.2. *Food Security in Middle Income MENA Countries*

Regarding the food availability dimension, the middle-income countries of the MENA, such as Algeria, Tunisia, Jordan, Egypt, Morocco, and Iraq are considered high food-consuming countries, as the average food supply in the selected middle-income MENA countries is 1814 kcal/day. Wheat and major cereals represent the largest portion of the dietary energy supply (DES) for MENA countries, and the selected middle-income MENA countries are not the exception, as the dietary energy supply from cereals represents about 50% of the total DES. The selected middle-income MENA countries are below the daily global protein consumption, in which middle-income MENA countries consume 88 kcal/day, while the daily global protein consumption is 89 kcal/day. In terms of the food access dimension, the rail line density is decent in the selected middle-income MENA countries due to the large total area and good transport (rail) infrastructure of those countries. The selected high-income MENA countries have a low prevalence of undernourishment (% of population), except Jordan (17%) and Iraq (16%). GDP

Table 2 - Food security situation in high-income MENA countries (2022).

Food Security Dimension and Indicators	*United Arab Emirates*	*Kuwait*	*Saudi Arabia*	*Oman*
Food Availability				
Min. Dietary Energy Supply Requirement (kcal/pc/d)	2040	1916	1870	1876
Food Production Index (2014-2016 = 100)	125	123	159	144
Dietary Energy Supply from Cereals (g/capita/day)	775	805	898	807
Average Protein Supply (g/capita/day)	140	127	144	129
Average Supply of Fat (g/capita/day)	134	104	95	98
Food Access				
Rail lines (total route-Km)	279	145	2939	333
Consumer - Food Price Index (2015 = 100)	115	127	126	106
Prevalence of Undernourishment (%)	6	3	4	10
Gross Domestic Product per Capita (No.)	53758	432334	30436	25057
Food Utilization				
Safely Managed Drinking Water Services (%)	99	100	98	91
Safely Managed Sanitation Services (%)	98	100	80	90
Children under 5 years old - Stunting (%)	13	7	12	13
Children under 5 years old - Wasting (%)	8	2	5	9
Children under 5 years old - Underweight (%)	2	3	4	11
Food Stability				
Cereal Import Dependency Ratio (%)	94	98	86	87
Agricultural Irrigated Land (%)	24	0.3	0.7	8
Food imported (% of Merchandise Exports)	5	7	7	8
Political Stability	1	1	-1	1
Average Trade Openness (%)	100	99	76	83
Gini index	0.59	0.64	0.65	0.67

Source: FAO, FAOSTAT - Food Security and Nutrition: Suite of Food Security Indicators.

per capita in the selected middle-income MENA countries is low ($9,883) compared to the global GDP per capita ($18,381) in 2022. About 23% of the total population in the selected middle-income countries suffers from unsafely managed drinking water services, and 32% of the population uses unsafely managed sanitation services. About 18% of children under 5 years old suffer from stunting, being underweight, or being affected by wasting in the selected middle-income MENA countries. In terms of the food stability dimension, the average dependence of the selected middle-income MENA countries on cereal imports is high (60%). The selected middle-income MENA countries have a low political stability indicator and those countries are suffering from a severe income gap between their populations based on the Gini index indicator. Therefore, those countries can face a high food instability shock scenario (Table 3).

4.3. *Food Security in Low Income MENA Countries*

Regarding the food availability dimension, the low-income countries of the MENA, such as Sudan, Lebanon, and Yemen have some sort of food supply shortage, as the average consump-

Table 3 - Food security situation in middle-income MENA countries (2022).

Food Security Dimension and Indicators	*Algeria*	*Tunisia*	*Jordan*	*Egypt*	*Morocco*	*Iraq*
Food Availability						
Min. Dietary Energy Supply Requirement (kcal/pc/d)	1787	1816	1831	1821	1845	1781
Food Production Index (2014-2016 = 100)	105	103	102	103	116	124
Dietary Energy Supply from Cereals (g/capita/day)	894	908	842	1202	1144	1069
Average Protein Supply (g/capita/day)	88	97	82	102	109	53
Average Supply of Fat (g/capita/day)	100	97	85	60	76	53
Food Access						
Rail lines (total route-Km)	4001	1777	507	5153	2295	2370
Consumer - Food Price Index (2015 = 100)	150	168	105	367	129	116
Prevalence of Undernourishment (%)	3	3	17	5	6	16
Gross Domestic Product per Capita	4274	3777	4205	4295	3528	5937
Food Utilization						
Safely Managed Drinking Water Services (%)	71	74	86	97	75	60
Safely Managed Sanitation Services (%)	62	81	82	67	61	53
Children under 5 years old - Stunting (%)	9	9	7	20	13	10
Children under 5 years old - Wasting (%)	3	2	1	8	2	3
Children under 5 years old - Underweight (%)	3	2	3	7	3	4
Food Stability						
Cereal Import Dependency Ratio (%)	70	55	93	43	37	56
Agricultural Irrigated Land (%)	3.3	3.9	8.8	3.4	6	4.5
Food imported (% of Merchandise Exports)	22	13	43	47	16	12
Political Stability	-1	-1	-1	-1	-1	-2
Average Trade Openness (%)	58	50	111	50	61	132
Gini index	0.49	0.57	0.59	0.57	0.60	0.61

Source: FAO, FAOSTAT - Food Security and Nutrition: Suite of Food Security Indicators.

tion in the selected low-income MENA countries is 1756 kcal/day, while the global average is 1827 kcal/day. Moreover, wheat and major cereals represent the largest portion of the dietary energy supply (DES) for MENA countries, and the selected low-income MENA countries are not the exception, as the dietary energy supply from cereals represents about 55% of the total DES. The selected low-income MENA countries have a low protein consumption of 67 kcal/day, compared to average global consumption of 89 kcal/day. The selected low-income MENA countries have a high prevalence of undernourishment (% of population), and the average POU of those countries is 22% of the total population. The GDP per capita in the selected low-income MENA countries is low ($6,400) compared to the global GDP per capita ($18,381) in 2022. About 58% of the total population in the selected low-income countries suffers from unsafely managed drinking water services, and 34% of the population uses unsafely managed sanitation services. About 63% of children under 5 years old suffer from stunting, being underweight, or being affected by wasting. In terms of the food stability dimension, the average dependence on cereal imports is high (74%). The selected low-income MENA countries are suffering from

Table 4 - Food security situation in low-income MENA countries (2022).

Food Security Dimension and Indicators	*Countries With Low Income Level*		
	Sudan	*Lebanon*	*Yemen*
Food Availability			
Min. Dietary Energy Supply Requirement (kcal/pc/d)	1728	1829	1712
Dietary Energy Supply from Cereals (g/capita/day)	899	805	1113
Average Protein Supply (g/capita/day)	68	83	50
Average Supply of Fat (g/capita/day)	71	104	42
Food Access			
Rail lines (total route-Km)	4313	401	47
Prevalence of Undernourishment (%)	13	11	41
Gross Domestic Product per Capita	4216	14331	3437
Food Utilization			
Drinking Water Services (%)	65	48	62
Safe Sanitation Services (%)	57	26	19
Children under 5 years old - Stunting (%)	36	8	35
Children under 5 years old - Wasting (%)	16	2	16
Children under 5 years old - Underweight (%)	33	3	40
Food Stability			
Cereal Import Dependency Ratio (%)	42	94	87
Political Stability	-2	-1	-3
Gini index	0.45	0.65	0.35

Source: FAO, FAOSTAT - Food Security and Nutrition: Suite of Food Security Indicators.

political instability and income gap between their populations based on the Gini index indicator. Therefore, those countries can face a food instability shock (Table 4).

4.4. *Food Security in the Selected MENA Countries*

In terms of food availability, the selected high-income MENA countries have a higher food supply than the selected middle-income and low-income MENA countries. The United Arab Emirates has the highest food supply among all MENA countries (2040 kcal/day), while Yemen has the lowest food supply among all MENA countries (1712 kcal/day). Wheat and major cereals represent the largest portion of the DES for the selected MENA countries, about 50% of the total DES. The daily protein supply in the selected high-income MENA countries is greater than that in middle- and low-income MENA countries. The United Arab Emirates has the greatest amount of protein supply (140 kcal/day), while Yemen has the smallest amount of protein supply among all MENA countries (50 kcal/day). In terms of food access, the selected high-income MENA countries have a low prevalence of undernourishment among their population compared to the selected middle-income and low-income MENA countries, where Yemen has the highest prevalence of undernourishment among their population (41% of the total population). The GDP per capita in the selected high-income MENA countries is greater than the selected middle-income and low-income MENA countries since those countries have oil-exporter-based economies. In terms of food utilization, the selected high-income MENA countries have better and more safe drinking water and sanitation services than the selected middle- and low-income MENA countries. All the

Table 5 - Food security determinants and weights in the MENA region (2022).

Food Security Determinant	*Determinant Weight by Author*	*Food Security Determinant*	*Determinant Weight by Author*
Min. Dietary Energy Supply Requirement	0.07	Drinking Water Services	0.26
Dietary Energy Supply from Cereals	0.03	Safe Sanitation Services	0.25
Food Production Index	0.30	Child Malnutrition	0.49
Average Protein Supply	0.40	*Food Utilization (Total Weight)*	*1.00*
Average Fat Supply	0.20	Cereal Import Dependency Ratio	0.49
Food Availability (Total Weight)	*1.00*	Agricultural Irrigated Land	0.08
Rail lines Density	0.20	Political Stability	0.07
Consumer - Food Price Index	0.40	Average Trade Openness	0.31
Prevalence of Undernourishment	0.40	Gini index	0.05
Food Access (Total Weight)	*1.00*	*Food Stability (Total Weight)*	*1.00*

Source: Author.

selected MENA countries have high malnutrition among the children under 5 years old. In terms of food stability, the selected high-income MENA countries have a higher dependency on cereal imports than the selected middle-income and low-income MENA countries since the middle-income countries have agriculture-based economies. All the selected MENA countries except the UAE, Kuwait, and Oman have political instability, especially Yemen, which has the highest political instability (-3) among MENA countries; Sudan and Iraq are in second place (-2). All the selected MENA countries are suffering from a severe income gap between their populations, based on the Gini index indicator. Therefore, those countries can face a high food instability shock scenario. Therefore, the author can conclude that the selected MENA countries, except low-income MENA countries, have some sort of stability in both food availability and access dimensions. On the other hand, all the selected MENA countries, without exception, have instability in both food utilization and stability dimensions.

4.5. *Food Security Determinants in MENA Region*

At the econometric analysis level, the author builds four main models using the same food security indicators to examine the food security determinants in the selected MENA countries according to the four food security dimensions. The adopted models use the same explanatory variables to understand the effects of each determinant on the food security dimension and tackle which macroeconomic factors have more influence on food security in MENA region (Table 5). The potential determinants were discussed in the literature review section.

4.6. *Food Security Performances in the MENA Region*

The author combines the results of food security indicators from (Tables 2, 3, and 4) with food security determinants and weights from (Table 5) to calculate the food security score in the selected MENA countries (Table 6) and for identify of significance level of different variables' scores (Appendix 1). The results of (Table 6) show that the United Arab Emirates have the highest food security score among all the MENA countries, while Sudan has the lowest food security score in the MENA region. In terms of food availability and access, most MENA countries have a high and/or decent score (good food supply performance) except Sudan and Yemen. In terms of food utilization, all the MENA countries have a very low score (bad food safety performance). In terms of food stability, most

MENA countries have high stability (low food instability-shock and/or exposure), except Tunisia, Egypt, Morocco, and Sudan, because those countries have a high population with low- or middle-income levels.

5. Recommendation and Conclusion

Based on the results obtained by the study, there is no doubt that the current food security situation in the MENA region is surrounded by uncertainty and bleak due to several domestic and global challenges, such as a rapid increase in population growth rate, a global slowdown in economic growth rate, climate change impacts, a reduction in water resources, the spreading of political instability, the prevalence of malnutrition, low food production, high food import dependency, weak transport infrastructure, weak drinking water and sanitation services, and suffering from a severe income gap between the population of this region. The study contributes to tackling the current food security situation in the MENA region by focusing on investigating the food security determinants and weights to understand the role of macroeconomic factors in improving food security performance in the MENA countries. The findings confirm that food utilization and stability dimensions in MENA countries have less attention given to them by the governments in those countries.

So, the author recommends that, in order to improve the performance of food security in the MENA region, the following can be done: one of the interventions that can be used to reduce the risks associated with high dependence on food imports by MENA countries is that each one has to manage the economic risks associated with volatile food prices, in which governments reduce the price volatility of commodities and food import costs, stabilize budgets, and develop tools for commodity markets. Moreover, improving the efficiency of the agriculture sector will lead to a rise in economic growth by reducing food imports through the adoption of the latest effective agricultural practices and technologies that respond to climate change, such as aeroponics and hydroponics. In addition, improve the safe management of drinking water and sanitation services. Another government intervention, reforming the social protection system especially during food instability-shock condition such as, nets of social safety and food aid programs targeting those most vulnerable

Table 6 - Food security scores in the MENA countries (2022).

Country	*Food Availability Score (%)*	*Food Access Score (%)*	*Food Utilization Score (%)*	*Food Stability Score (%)*	*Overall Food Security Score (%)*
UAE	23	23	10	21	77
Kuwait	21	23	11	21	76
Saudi Arabia	23	21	9	17	70
Oman	22	22	7	19	70
Algeria	17	20	7	14	58
Tunisia	17	22	8	12	59
Jordan	16	20	9	20	65
Egypt	17	18	6	10	51
Morocco	18	21	6	10	55
Iraq	14	18	5	16	53
Sudan	15	7	4	8	34
Lebanon	16	12	3	18	49
Yemen	12	14	7	15	48

Source: Author.

groups or households as a major key to ensuring that food is affordable.

Food security is a complex global phenomenon with many different dimensions affected by several macroeconomic factors. So, it is a necessity for all MENA countries to invest in the rural development of the region to achieve a higher food availability score. Creating economic opportunities, especially in rural areas, will lead to a higher food access score. Maintaining and developing both the economic and environmental resources, for example, by increasing people's access to better sanitation and water services, will ensure environmental sustainability and raise the food utilization score. Reducing cereal import dependency and conflicts in the region (increasing the political stability indicator) will lead to a better food stability score. Finally, policies and intervention programs at both local and regional levels should differ according to the targeted dimensions of food security and based on each MENA country's situation to increase the overall food security score, mainly for the food utilization dimension.

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Appendix 1 - Significance level of different variables' scores.

Variable/Indicator	*Food Security Score*
Min. Dietary Energy Supply Requirement (kcal/pc/d)	0.0006**
	-0.0466
Food Production Index (2014-2016 = 100)	0.07091*
	-0.0887
Dietary Energy Supply from Cereals (g/capita/day)	0.0788**
	-0.0474
Average Protein Supply (g/capita/day)	0.0015**
	-0.0252
Average Supply of Fat (g/capita/day)	0.0120*
	-0.1351
Rail lines (total route-Km)	0.0877*
	-0.0739
Consumer - Food Price Index (2015 = 100)	2.7657*
	-1.2029
Prevalence of Undernourishment (%)	-1.4307
	-1.3132
Drinking Water Services (%)	0.0032*
	-0.0810
Safe Sanitation Services (%)	0.0017**
	-0.0212
Child Malnutrition	-2.4499*
	-1.3163
Cereal Import Dependency Ratio (%)	0.0229**
	-0.0405
Agricultural Irrigated Land (%)	0.1198*
	-0.0685
Political Stability	0.0004***
	-0.0091
Average Trade Openness (%)	0.0450
	-0.3993
Gini index	0.0354**
	-0.0126

Source: Author
**** p<0.01, ** p<0.05, * p<0.1*