

Food Insecurity, Food Waste, and Food Redistribution among Arabic-Speaking Countries: A Systematic Review

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ABSTRACT

Over 20% of Arabs are food insecure; almost double the global figure (10.9%). Malnutrition also is the greatest challenge that nations with conflict are facing, despite the presence of several agencies that redistribute surplus food to the impoverished. Yet, this society wastes 34% of its food. Therefore, the objective of this paper is to discuss food insecurity, food waste, and redistribution in 22 Arabic-speaking countries. War, poverty, harsh climate conditions, limited agricultural resources, and food disposal are other risk factors for food insecurity. However, food redistribution would help in diminishing the gap between food waste and insecurity, which deserves further investigation. Other solutions include the development of agricultural projects; desalination of seawater and/or building dams, use of biotechnology to boost crop productivity and its nutrition quality, and resistance to drought and pests, adoption of food-waste reduction technologies; and development of new regulations/laws via tax reduction for donors and displaying fines for wasting food. Finally, the present review differs from other published manuscripts in that it establishes a database for researchers regarding not only food waste, but also describes reasons and suggested solutions to reduce hunger and food insecurity in the Arab world.

Keywords: Arabic-speaking countries; Food insecurity; Food waste; Food redistribution.

INTRODUCTION

Food insecurity is the inaccessibility to uncontaminated nutritionally adequate foods in sufficient quantities due to limited resources (Thompson *et al.*, 2012). This health problem started to surface in the Arab world after the Millennium. Nearly 420 million individuals live in 22 Arabic-speaking countries (World Bank Data, 2019), which occupy 13.15 million km² of

Asia and Africa (Index Mundi, 2019; BBC News, 2017).

Figure (1) shows that Arabic-speaking countries consist of 10 African nations and 12 Middle-Eastern states. Eight of the latter group are located at the Persian Gulf and Arabian Sea (BBC News, 2017; World Bank in the Gulf Cooperation Council, 2019).

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Figure 1. Map of the Arab World (BBC News, 2017)*.

*Algeria, Comoros, Djibouti, Egypt, Libya, Mauritania, Morocco, Somalia, Sudan, and Tunisia are African countries; and Bahrain, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, UAE, and Yemen are located at the Persian Gulf and the Arabian Sea.

More than 20% of Arabs are food insecure (FAO, 2019a; Global Hunger Index, 2019; Global Food Security Index 2018); almost double the global figure (10.9%) (FAO, IFAD, WHO, WFP, and UNICEF, 2018). Generally, the main reasons for food insecurity are the food gap between production and consumption; poverty and low wages; unattainable food prices (Khoudari, 2014; Saab, 2015); and food waste or loss (EPA, 2016; Gustafson, 2016), but such information is not fully explored in the Arab world. Food waste is the food lost during food production, and food loss is throwing away food despite being suitable for consumption (Gustafson, 2016).

Lack of food security predisposes individuals to malnutrition (Thompson *et al.*, 2012) or obesity (Dhurandhar *et al.*, 2016) as presented in **Figure-2**, based on accessibility to food and the kind of food consumed. International agencies, therefore, collaborated to abolish food insecurity among Arabs, by developing innovative agroecological systems via using ecosystems and resources recycling in farming and food production (ICARDA, 2018a; Relief Web, 2018a), to generate sustainable food sources (FAO, 2018a; ICARDA, 2018a). Moreover, food redistribution, which redirects surplus food from ending in landfills to feed the impoverished, would help in the reduction of food insecurity and food loss (EPA, 2016; Gustafson, 2016). This is vital because of wasting 33.3% (FAO, 2019b; Gustafson, 2016) and 34% (Abiad and Meho, 2018) of the produced food in the world and Arab states, respectively. Saving about one-sixth of food from disposal could feed 250,000,000 persons of the world (Gunders, 2012), whereas salvation of half of the wasted food will probably nourish one billion of the universe's inhabitants (Lemmon, 2014). Thus, this paper aims to discuss food insecurity and food waste in the 22 Arabic-speaking countries, suggest solutions to reduce these problems, and raise awareness about the essential role of food redistribution in diminishing hunger. This review also will discuss the health issues that require investigation across the Arab nation such as malnutrition and famine.

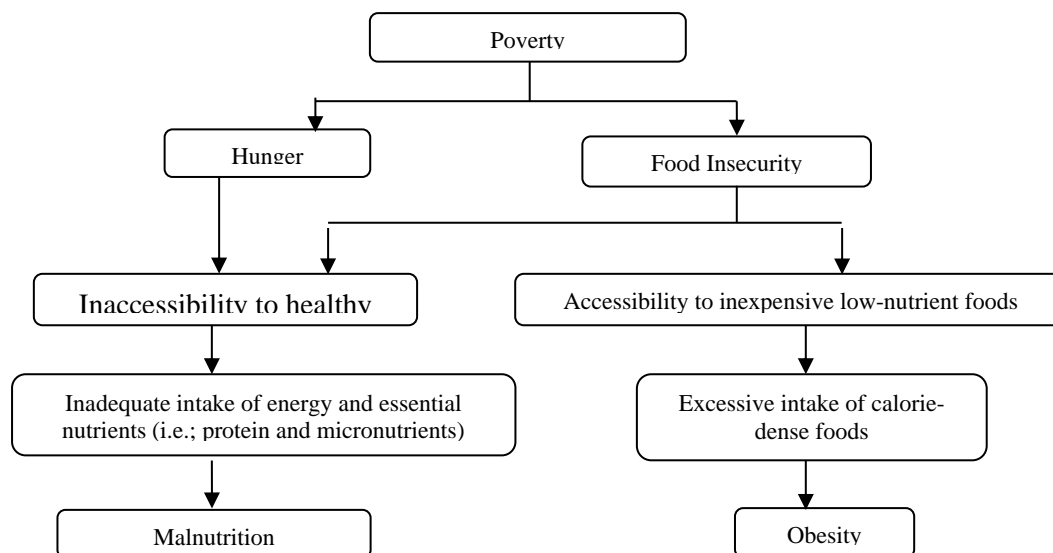


Figure 2. Poverty and food insecurity-obesity paradox (Dhurandhar, 2016; Thompson *et al.*, 2012).

Materials and Methods

Search Strategy

The author performed a thorough literature search using the Institute for Scientific Information Web of Knowledge, CAB Direct, Cochrane Library, ProQuest Central, EBSCO's Academic Search Ultimate, PubMed, Middle Eastern and, Central Asian Studies, Index Islamicus, Al-Manhal, and Google Scholar databases. Articles published from January 1970 to September 2019 were identified using the following keywords and terms: "food security," "food insecurity", "undernourishment," "malnourishment," "hunger," "disposing or wasting food," "throwing away food," "food waste," "food loss or lost," " food disposal," "food end in landfills or dumpsters," "food rescue," "food redistribution," "food collection or allocation," "rescuing food," "collecting food," "food bank," "food donation," "food assistance," "food aid," "Arab," "North Africa," and "The Middle East." Moreover, the countries included in the search are Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan,

Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates (UAE), and Yemen.

Selection Process

This process included publications that discussed at least one of the three main topics: food insecurity, food waste/loss, and food rescue and redistribution in the 22 Arabic-speaking states. Exploration of articles resulted in 638 items. The number of articles left after excluding the duplicates was 506. Then the researcher assessed the title and abstract fields, identifying 172 irrelevant items. In the third step of the search, the researcher examined the full text of the remaining 334 papers (**Figure-3**).

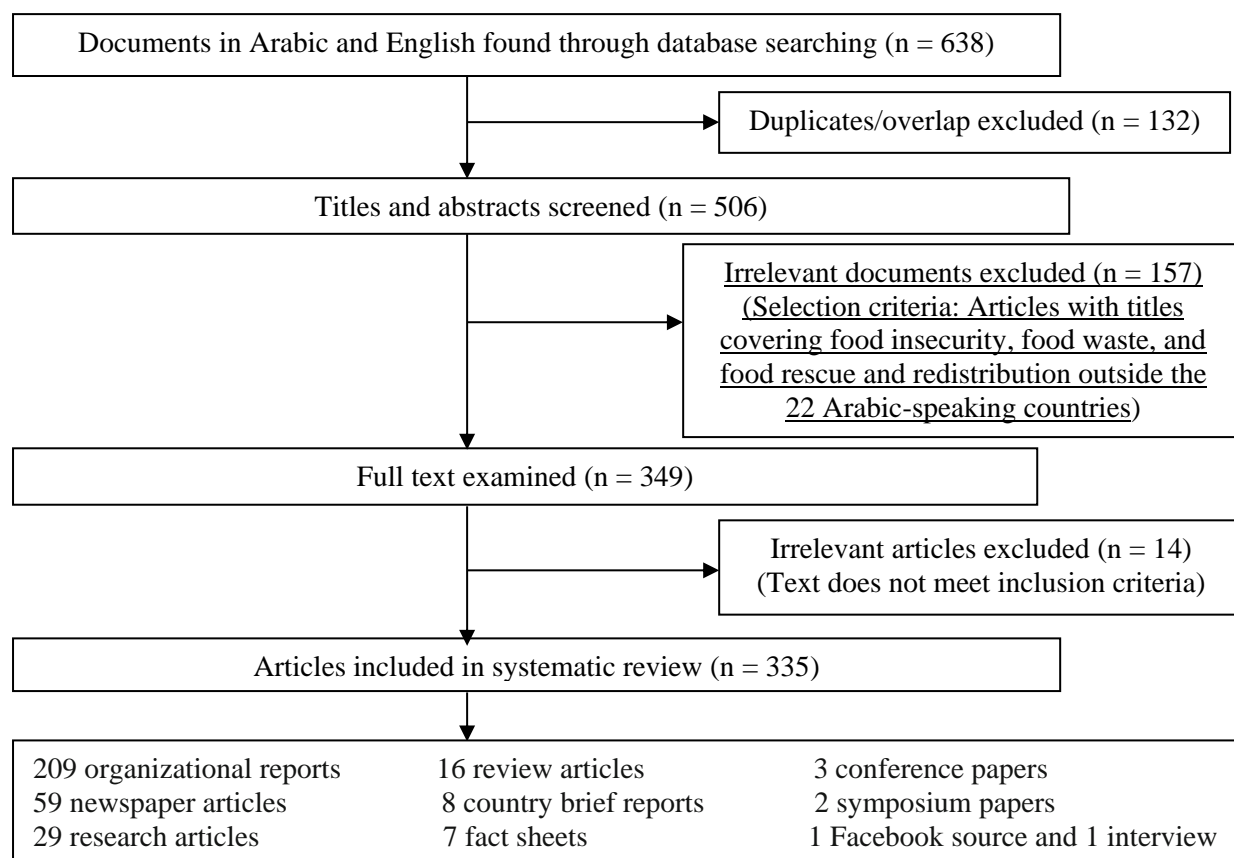


Figure 3. Flow chart of the search and selection process of studies on "food insecurity", "food waste/loss", and "food rescue and redistribution" in the Arab world.

The investigator also assessed the qualitative content analysis and risk of bias for the research and review papers. There was only selection and reporting bias. The former had a high risk because only nine studies randomly selected participants (Abuamoud *et al.*, 2016; Al-Domi *et al.*, 2011; Al-Rawi and Al-Tayyar, 2012(a); Ghattas *et al.*, 2018; Jamil *et al.*, 2016; Khatib and Arafat, 2010; Sassi *et al.*, 2016; Sulaymon *et al.*, 2010; Yasir and Abudi, 2009). The latter, however, had a low risk due to reporting all data described in the objectives and methods.

Results and Discussion

Food Insecurity

The prevalence of food insecurity and hunger widely vary among Arabs irrespective of their geographical location (**Figure-4**). For instance, Kuwait, Tunisia, Saudi Arabia, and Algeria had a Global Hunger Index < 10% [the degree of undernourishment, child wasting, stunting, and mortality in a population (Global Hunger Index, 2019)]. Yet, this percentage ranged between 10.4% and 14.8% in Morocco, Oman, Jordan, Lebanon, and Egypt, but increased to > 22% in Iraq and Mauritania (Global Hunger Index, 2019). Moreover, these proportions exceeded 30% in Djibouti, Comoros,

Sudan, and Yemen, reaching 58.3% in Syria (Global Hunger Index, 2019). **Figure-4** also indicates that the level of Global Food Security Index [the number of the insecure according to food affordability, availability, quality, and safety (Global Food Security Index, 2018)] was greatest in Sudan (25.6%) and Yemen (28.8%), even higher than that of the Arab region (21%) (Global Food Security Index, 2018) and worldwide (11%) (FAO, IFAD,

WHO, WFP, and UNICEF, 2018). On the contrary, Bahrain had a zero percent, and Kuwait, the UAE, Jordan, Saudi Arabia, Egypt, Algeria, and Oman had much smaller figures (2.5% - 6.2%) (Global Food Security Index, 2018).

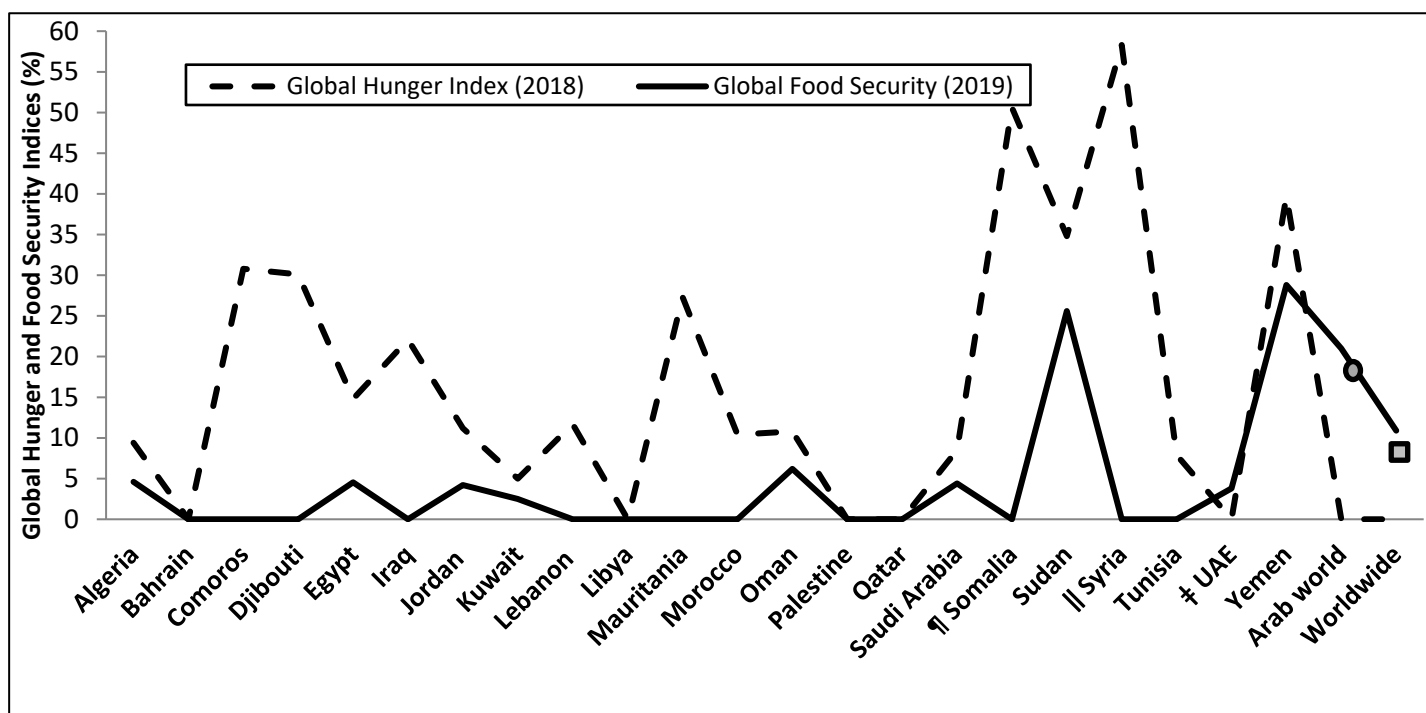


Figure 4. Global Hunger (Global Hunger Index, 2019) and Food Security Indices (Global Food Security Index, 2018) for the 22 Arabic-Speaking Countries*.

* The following countries lack data about the Global Hunger Index levels: Bahrain, Libya, Qatar, Somalia, and Syria (Global Hunger Index, 2019), whereas the following countries do not have information about the rates of Global Food Security Index: Comoros, Djibouti, Iraq, Lebanon, Libya, Morocco, Mauritania, Palestine, Qatar, Somalia, Syria, and Tunisia (Global Food Security Index, 2018).

Besides the global indices, Bahrain (Bahrain Business Magazine, 2017; Bahrain Economic Development Board, 2014) and Kuwait (Kuwait International Agro Food Expo, 2018) were the most food-secure nations, followed by Qatar (The Peninsula, 2018), Tunisia (FAO, 2019a), and Saudi Arabia (FAO, 2019a). Furthermore, the prevalence

of food insecurity was moderate in Jordan and Lebanon, which are the countries with the greater number of investigations on this issue (**Table-1**).

Table 1. Summary of the research papers on food security and food waste in Arabic-speaking countries.

Country	Goal	Data collection method	Reference, year
Algeria	Estimation of household food waste in Algeria	An online survey conducted over 2 months and assessed 323 residences	Arous <i>et al.</i> , 2017
Egypt	Assessment of food purchase and expenditure, nutrition knowledge about food labeling, food waste attitudes, amount and value of household food waste, and readiness to reduce food waste	Online survey and face-to-face interviews with a random sample of 181 adults over 4 months	Abdelradi 2018
Egypt	Measurement of solid waste generated from an economy class in-flight	12 Egypt Air-flight representatives	Elmenofi <i>et al.</i> 2015
Iraq	Solid waste chemical composition in Bassrahed	Chemical analysis of solid waste using a cylindrical container	Abbas <i>et al.</i> 2016
Iraq	Evaluation of the quantity and monetary value of wasted grain products in restaurants in Erbil	Survey of 50 randomly selected restaurants	Jamil <i>et al.</i> , 2016
Iraq	Quantification of the generated household waste and its composition in Karbala	Analysis of 70 households waste over winter and summer from 35 districts	Al-Mas'udi and Al-Haydari, 2015
Iraq	Solid waste chemical composition in Bahgdad	2520 samples collected within 6 months	Abd Al-Kareem, 2014
Iraq	Analyze kitchen food waste at the household level and its determinants in Bahgdad	Collected data from 20 families using a survey over 8 months	Al-Maliky and ElKhayat, 2012
Iraq	Assessment of physical and chemical composition of household waste in Mosul	Analyzed 1680 waste samples collected during 6 months	Al-Rawi and Al-Tayyar 2012(a)
Iraq	Determination of household waste generation and composition in Mosul	Face-to-face survey of households in selected districts, and examining 252 household waste samples	Al-Rawi and Al-Tayyar, 2012(b)
Iraq	Behavioral assessment of household solid waste management, and estimation of the quantity and composition of the generated waste in Al-Kut	Surveying 80 households accompanied by collecting household waste samples over 7 months	Sulaymon <i>et al.</i> , 2010
Iraq	Measurement of the composition and characteristics of the generated household waste in Nassiriyah	A sample of 65 households was recruited from 3 districts to analyze their waste	Yasir and Abudi, 2009
Jordan	Evaluation of food security of house-holds of Jordanians living in Northern Badia	Interviewed 200 heads of families from 26 villages for 2 months	Abuamoud <i>et al.</i> , 2016
Jordan	Assessment of plate waste in Amman	A sample of 600 university students filled out a self-administered questionnaire during one academic year	Al-Domi <i>et al.</i> , 2011

Table 1. Continued.

Country	Goal	Data collection method	Reference, year
Jordan	Investigation of food insecurity in Northern Badia	A questionnaire was used to interview 500 women over 1-year	Bawadi <i>et al.</i> , 2012
Jordan	The Department of Statistics discussed the state of food security in Jordan	A one-year survey assessed food security among Jordanians	Department of Statistics of Jordan, 2016
Kuwait	Examination of household food consumption and waste in Kuwait	Surveying 1,300 families for one month	Aljamal and Bagnied, 2012
Lebanon	Measurement of household food waste in Lebanon	An online survey was completed by 215 adult consumers over 2 months	Charbel <i>et al.</i> , 2016
Lebanon	Exploration of poverty and food insecurity in refugees residing in Lebanon	A 1-month survey was used to interview 2,974 Palestinian refugees and 1,050 Syrian immigrants	Ghattas <i>et al.</i> , 2018
Lebanon	Determination of the effect of community kitchens on the food security of their workers and Syrian refugees in Lebanon	After 3 months, 15 women working in community kitchens and 49 Syrian women have completed a questionnaire	Ibrahim <i>et al.</i> , 2019
Lebanon	Assessment of food insecurity and its associated factors in Lebanon	The 1-year survey examined 1,204 households	Jomaa <i>et al.</i> , 2019
Morocco*	Measurement of food waste in households of Moroccans	In 3 months, 122 adults filled an online survey	Abouabdillah <i>et al.</i> , 2015
Oman	Estimation of municipal solid waste in Muscat	A sample of 22 solid and leachate samples was gathered over one month	Baawaina <i>et al.</i> , 2017
Oman	Quantification of food plate waste in a family	A sample of 21 family members (47.6% males and 52.4% adults)	Kotagama, 2012
Palestine	Evaluation of practices followed to manage solid waste in the West Bank and Gaza Strip, and assessment of the rate at which the waste is generated, its component, and disposal methods	A sample of 4073 household heads was surveyed over 2 months	Al-Khatib and Arafat, 2010
Qatar	Discernment of household food waste in Qatari	Over a 1 month, 744 Qataris and 1,707 non-Qataris were surveyed	Elawad <i>et al.</i> , 2018
Saudi Arabia**	Description of the importance of public awareness among Saudis regarding food waste	Not described	Al-Zaharani and baig, 2014

* A symposium research paper.

** A conference research paper.

Table 1. Continued.

Country	Goal	Data collection method	Reference, year
Saudi Arabia	Quantification of the amount of food served and wasted during a pilgrimage in Makkah	245 pilgrims were surveyed	Amara <i>et al.</i> , 2013
Saudi Arabia	Chemical Analysis of the composition of food plate waste in Riyadh	A 6-day survey collected data from 90 university students, accompanied by chemical composition analysis of food waste for 60 plates	Al-Othman and Hewedy, 1996
Saudi Arabia	As of the monetary value of the edible food plate waste in selected hospitals in Riyadh	In 18 hospitals, estimation of plate waste was performed for 6 consecutive meals over a pove 2 days, via surveying 554 patients and 205 attendants	Alshoshan, 1992
Saudi Arabia	Discussion of food was a serious threat to food sustainability and security	A systematic review of 54 report	Baig <i>et al.</i> , 2019(a)
Saudi Arabia	Addressing food waste effect on food security	A review of 10 reports	Baig <i>et al.</i> , 2019(b)
Tunisia	Documentation of household food waste in Tunisia	A population sample of 281 adults was interviewed in 2 months	Sassi <i>et al.</i> , 2016
United Arab Emirates	Evaluation of the generated household food waste and its composition	A 3-week survey collected 840 samples of food waste from 40 houses	Abu Qdais <i>et al.</i> , 1997
United Arab Emirates	Estimation of the food waste through the foodservice chain, and exploration of the causes and steps of food waste generation in the hospitality industry	Surveying 45 hotels and restaurants	Pirani and Arafat, 2016
More than one country			
Middle Eastern countries	Evaluation of the effect of urbanization on food security, poverty, and health in Amman (Jordan) and Manama (Bahrain)	Comparing food security factors, poverty, and urbanization of Amman with these of Manama using the FAO Food Insecurity and Vulnerability Information and Mapping Systems	Galal <i>et al.</i> , 2010
Mediterranean Arab states	Investigation of waste of bread and bakery products in Algeria, Egypt, Lebanon, Morocco, and Tunisia	An online survey completed by 1,122 adults within a 4-month duration	Capone <i>et al.</i> , 2016

For instance, Bawadi *et al.* (2012) found that food insecurity was prevalent in about one-fifth of the women in Northern Jordan, and one-quarter had insufficient resources to purchase food. In 2016, Abuamoud *et al.* also showed that less than half of 207 households of Northern Badia were food insecure. Nonetheless, information about food security in the southern, eastern, and western parts of Jordan is not available, which requires assessment in the future. At the national level, a 2013/2014 survey (Department of Statistics, 2016) observed that the weekly intake of vegetables, fruits, dairy, and meat of the food insecure was lower than that of the food secure. Additionally, in 2018, 1%, 12%, and 13% of Jordanians were food insecure (WFP, 2018a), undernourished (WFP, 2019a), and vulnerable to lack food security (WFP, 2018a), respectively. In Lebanon, 13% and 21% of the population were moderately and severely food insecure, respectively in 2015 (Hwalla and Bahn, 2015). A recent survey also indicated that 49.3% of 1,204 households containing children aged 4-18 years lacked food security (Jomaa *et al.*, 2019). Families tried to overcome the scarcity of food by minimizing expenses, reducing food portions, and dropping children from school (Jomaa *et al.*, 2019); which may negatively influence children's health (Thompson *et al.*, 2012). Unfortunately, none of the reports explored the reasons for low food security in Jordan and Lebanon, which warrants conducting future longitudinal studies.

Nevertheless, food insecurity was higher in Egypt (36%) (FAO, 2019a), and in countries suffering from conflict including Libya, Palestine, Iraq, Mauritania, Djibouti, Syria, Sudan, Somalia, and Yemen ranging between 20% and 53%. For example in Libya, 22% of the population was food insecure in 2016 (FSIN, 2017; WFP, 2017a; WFP, 2016), and > 1.5 million required food assistance (World Bank in Libya, 2019; ACTED, 2018). About 17% of thousands of internally displaced Libyans also lacked food security, and 60% were at risk to become

food insecure (Worley, 2017). The prevalence of food insecurity was slightly greater in Palestinians (26.3%) (FAO 2019a). In 2004, food insecurity became two-fold that was reported in 2002 [27% (Food Security Sector, 2015) vs. 15% (Galal *et al.*, 2010)]. Moreover, in 2015, the UN reported that 16.3% and 46.7% of people living in the Gaza Strip and the West bank were undernourished, respectively (Food Security Sector, 2015). This change may be due to the war in the Holy Land and the siege around Gaza Strip, yet this implication deserves further examination.

In Iraq, despite receiving food donations, 36%, 48%, and 66% of 152 Iraqis reported insufficient income and food, and unavailability of clean water, respectively (Woertz, 2017). Furthermore, malnourishment and food insecurity were prevalent in 27% (ICARDA, 2018b) and 7% (FSIN, 2017) of Iraqis, correspondingly in 2016. In 2018 however, 29% was undernourished (WFP, 2019b). Among Mauritians, food insecurity almost doubled within one year [16% in 2017 (FSIN, 2017) vs. 31.6% in 2018 (IFRC, 2018)]. As a result, 217,000 adults and > 143,000 children needed humanitarian aid (WFP, 2016; UNICEF, 2018a). In Djibouti, within 4 years, lack of food security (NRC, 2019) increased from 14.5% in 2014 (TPSDE Facility, 2017) to 20.6% in 2016 (UN, 2017), to 42% in 2018 (WFP, 2018b). Thus, conflict accompanied by a shortness of resources could exacerbate food security status in Libya, Palestine, Iraq, Djibouti, and Mauritania, which urges prospective assessment.

After five years of civil war (started in 2011) and the ISIS invasion, 65% of Syrians was displaced (World Bank In Syrian Arab Republic, 2019), 35.1% lacked food security, 21.6% were vulnerable to food insecurity (HNO-WoS, 2018), and only 19% were food secure (Hendricks, 2019). In line with this, the secession of Southern Sudan in 2011 provoked the displacement of 4.9% of the population (Relief Web, 2018b). Consequently, 45% of Sudanese were food insecure (FSIN, 2017), 20.1%

undernourished (FAO, 2019a), and at least 7,000,000 individuals needed food (ACTED, 2018). In Somalia, 48% had low levels of food security (FSIN, 2017), 21% were malnourished, and 18% were susceptible to food insecurity (WFP, 2019c); thus, leaving one-third of the nation dependent on international supplies (Office of the Resident and Humanitarian Coordinator for Somalia, 2018). A worse situation is in Yemen in which numerous individuals spent a whole day on a piece of bread (Tinka, 2016), or dived in dumpsters for food (Al Jazeera, 2018). 53% of the people were severely food insecure (Integrated Food Security Phase Classification, 2019), and 39% were famished (FAO, 2019a). Conflict, therefore, may be a major contributor to food insecurity in these countries, as it results in poverty and shortage of food.

Risk Factors of Food Insecurity

In addition to war, poverty and unemployment are the second possible causes of low food security, which widely vary among the Arabic-speaking countries (5% and 89%). For instance, the lowest poverty rate was in Qatar (5%) (Abu-Ismaïl *et al.*, 2010; Bissada, 2017), followed by the UAE (8%) (Abu-Ismaïl *et al.*, 2010), and Bahrain (11%) (Galal *et al.*, 2010). A slightly higher number of poor [14.4% (Department of Statistics, 2015; WFP, 2018a)] and unemployed individuals [19% (Department of Statistics, 2019)] have been observed in Jordan. In Tunisia, the proportion of the impoverished was 18% (World Bank in Tunisia, 2019; UNICEF, 2017); yet this figure reached 24% (UNICEF, 2017), 27.4% (World Bank in Lebanon, 2019), and 28% (World Bank Arab in the Republic of Egypt, 2019) in Algeria, Lebanon, and Egypt, respectively. In Palestine, 29% of the households were poverty-stricken and 31% unemployed (World Bank in West Bank and Gaza, 2019). Nonetheless, greater levels of poverty were observed in Morocco (37%) (UNICEF, OPHI, and ESCWA, 2017), but the reason for such a high rate is not clear. Thus,

cohort studies should explore risk factors and solutions for these socio-economic problems.

The number of the poor was high in the war-torn nations and Comoros (UNICEF, 2017). In fact, within 12 years (2005-2017), this estimate in Comorians increased from 45% (World Food Program 2006) to 74% (UNICEF, 2017). In Libya, the percentage of the deprived almost tripled over 10 [15% in 2007 (Abu-Ismaïl *et al.*, 2010) vs. 40% in 2017 (Worley, 2017)]. This inflation could be attributed to the 2011-civil war following the Arab Spring (World Bank in Libya, 2019). In Iraq however, the poverty rate more than doubled within five years, increasing from 19% in 2012 (World Bank in Iraq, 2019; The World Federation of KSIMC, 2013) to 45.5% in 2017 (UNICEF, 2017). The deterioration in the socio-economic situation is due to the posed sanctions (Koc *et al.*, 2007) and the rise of ISIS in 2014 (Woertz, 2017), which displaced about 9 million Iraqis (RFSAN, 2017; USAID, 2018a).

Moreover, the 28- and 22-year civil wars in Somalia and Sudan resulted in the displacement of thousands of individuals, and the spread of poverty in about half and three-quarters of these populations, respectively (WFP, 2019c; World Bank in Sudan, 2019; UNICEF, 2017). Similarly, the conflict in Yemen raised the percentage of the poor from 49% in 2014 (World Bank in Yemen, Yemen, 2019) to 78% in 2019 (World Bank in Yemen, 2019). A comparable prevalence was reported among Djiboutians (79%) (World Bank in Djibouti, 2019, WFP, 2018b), and Syrians (80%) (Abdel Ghafar and Masri, 2016) who also > 50% of them lacked employment (WFP, 2019d). Lastly, the highest occurrence of the underprivileged was documented in Mauritania (89.1%) (World Bank in Mauritania, 2019; UNICEF, OPHI, and ESCWA, 2017), where 25% of the population survive on about a dollar/day (The Borgen Project, 2019). In Oman, the poverty rate was unavailable (UNICEF, 2013) and must be discerned in the future, but 40% of the citizens did not have a job (Sher, 2017).

The presence of refugees also could increase the risk of food insecurity in the countries of asylum. For example, Algeria provided shelter for 125,000 individuals evicted from Western Sahara (WFP, 2018c). Jordan also was the safe haven for millions of displaced Palestinians, Iraqis, and Syrians (Action Against Hunger - Jordan, 2019; JRPSC, 2019; WFP, 2018a). In addition, one-fifth of the Syrian immigrants lacked food security, and two-thirds were susceptible to food insecurity (UNHCR, 2015; WFP and REACH, 2019). A similar situation happened in Lebanon, which hosted 1.5 million Syrian (World Bank in Lebanon, 2019) and 46,000 Palestinian refugees (USAID, FAO, iMMAP, 2015). In 2018, Ghattas *et al.* indicated that 65% and 62% of 3,382 Palestinian immigrants, and 89% and 95% of 1,171 Palestinians relocated from Syria suffered from poverty and food insecurity, respectively (**Table-1**). Finally, in Mauritania and Somalia, food insecurity has worsened due to the influx of > 50,000 Malians (FEWS Net, 2018) and > 250,000 refugees (NRC, 2019), respectively. In all, peace seems to be the only solution that allows displaced persons to return home. However, until then, the international community should help the hosting nations to provide a means of income for citizens and refugees via initiating projects, in addition to the continual provision of humanitarian assistance.

Other reasons for food insecurity are inadequate food production, topography, and weather. In Oman for example, wheat cultivation decreased from 3,000 tons in 1975 to ~ 800 tons in 2005 (Kotagama *et al.*, 2009); hence, forcing Oman to depend on imported foods (Oxford Business Group, 2019). In Saudi Arabia (Ismail, 2015; Lippman, 2010; Lovelle, 2015) and the UAE (Mordor Intelligence, 2019) (SMCCU, 2014) (Fischbach, 2018), food availability was low due to the desert landscape, limited water resources, and scarcity of farmlands. In Tunisia, food processing inefficiency (Dhaou, 2016; FAO, 2016b; WFP, 2017b), and agricultural liberalization (Chemingui and Thabet, 2008)

have reduced food security. In Morocco, insufficient food production (Capone *et al.*, 2016; FAO, 2016a), climate change, high food prices, limited resources, and food inaccessibility also contributed to food insecurity (Huppé *et al.*, 2013).

Furthermore, the return of several refugees back to Syria, inadequate commodities (Human Appeal, 2018), high food prices (HNO-WoS, 2018), and destruction of food warehouses and irrigation ducts (El Dahan, 2016) have exacerbated malnutrition among Syrians. The current wheat production has dropped to 1,800,000 tons, which does not meet the nation's requirements (HNO-WoS, 2018). Before the war, however, Syria was food self-sufficient as it used to produce $\geq 4,000,000$ tons of wheat, and export a quarter of it (Human Appeal, 2018). Similarly, Yemen used to produce coffee (ACTED, 2018), seafood (Curtis *et al.*, 2016), and crude oil (World Bank in Yemen, 2019), before the war that started in 2015 (CEOBS, 2018). Yet, the ongoing conflict has decreased food production and raised food prices (Human Appeal, 2018; OXFAM, 2017); predisposing millions to hunger (Human Appeal, 2018).

In addition, the following climate issues have aggravated food insecurity in Djibouti, Mauritania, Somalia, and Sudan: the 2011/2012 Somalia Famine and East-Africa Drought (FAO, IFAD, WHO, WFP, and UNICEF, 2018; Relief Web, 2018c), inadequate rainfall (USAID, 2018b), small pasturelands and farmlands, pest manifestation of crops, and limited food storage, processing, and transport facilities (Office of Evaluation, 2015; The UN News, 2018; UNMISS, 2013), scarcity of water (FEWS Net, 2018), limited irrigation (The World Bank, FAO, and IFAD, 2009), death of a large number of cattle (FAO, 2018b; UN News, 2018), losing crops (Spotlight on Sudan, 2013), and high food prices (Thompson, 2018). Thus, developmental projects should be implemented to promote food plantation/production in these countries.

Food Waste and Loss

This review suggests that food waste or loss would induce food insecurity. **Figure (5-a)** shows the number of publications that investigated food waste and loss in the Arab world. Saudi Arabia [n = 12 (Al-Othman and Hewedy, 1996; AlShoshan, 1992; AL-Zahrani and Baig, 2014; Amara *et al.*, 2013; Arabian Business, 2018;

Baig *et al.*, 2019a; Baig *et al.*, 2019b; Dhaka Tribune, 2018; GDN Online, 2018; Lovelle, 2015; Mu'azu *et al.*, 2019; Sanu, 2018)], the UAE [n = 10 (Abu Qdais *et al.*, 1997; Arab Times, 2017; Arabian Business, 2018; Burger, 2018;

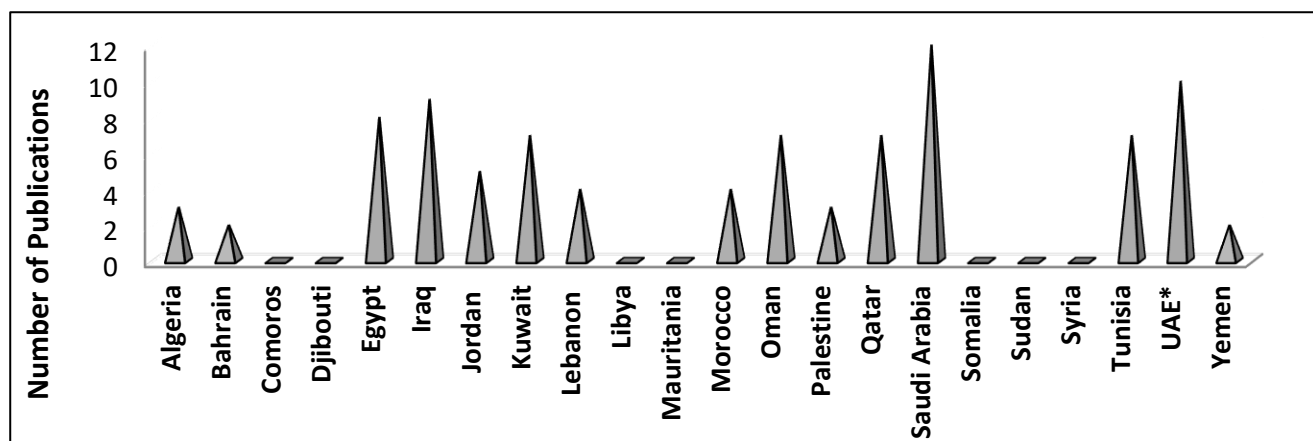


Figure 5a. The number of publications that investigated food waste and loss in Arabic-speaking countries.

* UAE: United Arab Emirates.

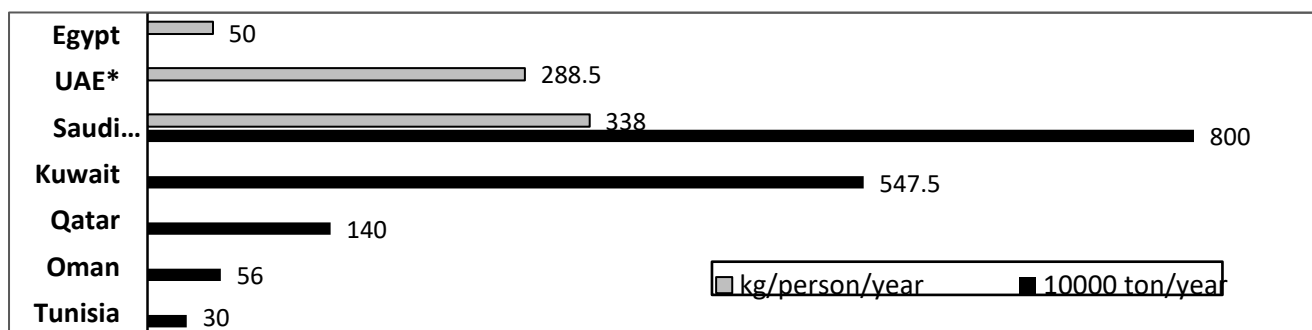


Figure 5b. The annual amount of food wasted per person (kg/person/year) and per nation (10000 ton/year).

* UAE: United Arab Emirates.

Department of Dubai, 2019; Abiad and Meho, 2018; Pirani and Arafat, 2016; Times of India, 2014; Zakaria, 2017; Zornes, 2019)], and Iraq [n = 9 (Abbas *et al.*, 2016; Jamil *et al.*, 2016; Al-Mas'udi and Al-Haydari, 2015; Abd

Al-Kareem, 2014; Al-Maliky and ElKhayat, 2012; Al-Rawi and Al-Tayyar, 2012(a); Al-Rawi and Al-Tayyar, 2012(b); Sulaymon *et al.*, 2010; Yasir and Abudi, 2009)] had the largest number of reports, whereas Algeria (Arous

et al., 2017; Capone *et al.*, 2016; El Bilali, 2018), Palestine (Bencivenni, 2017; Garrone *et al.*, 2017; Khatib and Arafat, 2010), Bahrain (BMMI Group, 2016; Trade Arabia: Business News Information, 2015), and Yemen (Browning, 2016; The Free Library, 2013) had ≤ 3 articles. Comoros, Djibouti, Libya, Mauritania, Somalia, Sudan, and Syria however, lacked documentation regarding food waste, thus needing further exploration.

Figure (5-b) describes the annual amount of food wasted per person and nation. Saudi Arabia was the only country that stated the quantity of disposed of food per person (Baig *et al.*, 2019b) and per population (Arabian Business, 2018; Mu'azu *et al.*, 2019). These values were the biggest in both sectors as compared to the UAE (Abiad and Meho, 2018), Egypt (The UN News, 2019),

Kuwait (Al-Arab Newspaper, 2018; COMCEC, 2017), Qatar (Adema, 2016), Oman (Al Maqhusi, 2018), and Tunisia (Capone *et al.*, 2016; FAO, 2016b; Sassi *et al.*, 2016).

Figure-6 also shows the extent of food lost as a percent of the total food produced and total waste was highest in Saudi Arabia (Baig *et al.*, 2019a; Lovelle, 2015; Sanu, 2018) and Lebanon (Nudge Lebanon, 2019), respectively (Figure-6). Yet, Jordan (Jordan GBC, 2016), Morocco (FAO, 2016b), Oman (Al Nasser, 2018; Kutty, 2018; Trade Arabia, 2018), Qatar (Abiad and Meho 2018), Kuwait (Al Fuzai, 2016), and the UAE (Arabian Business, 2018) had lower proportions. Variations in the amount of lost food between Arabic-speaking countries are unknown, which must be discerned.

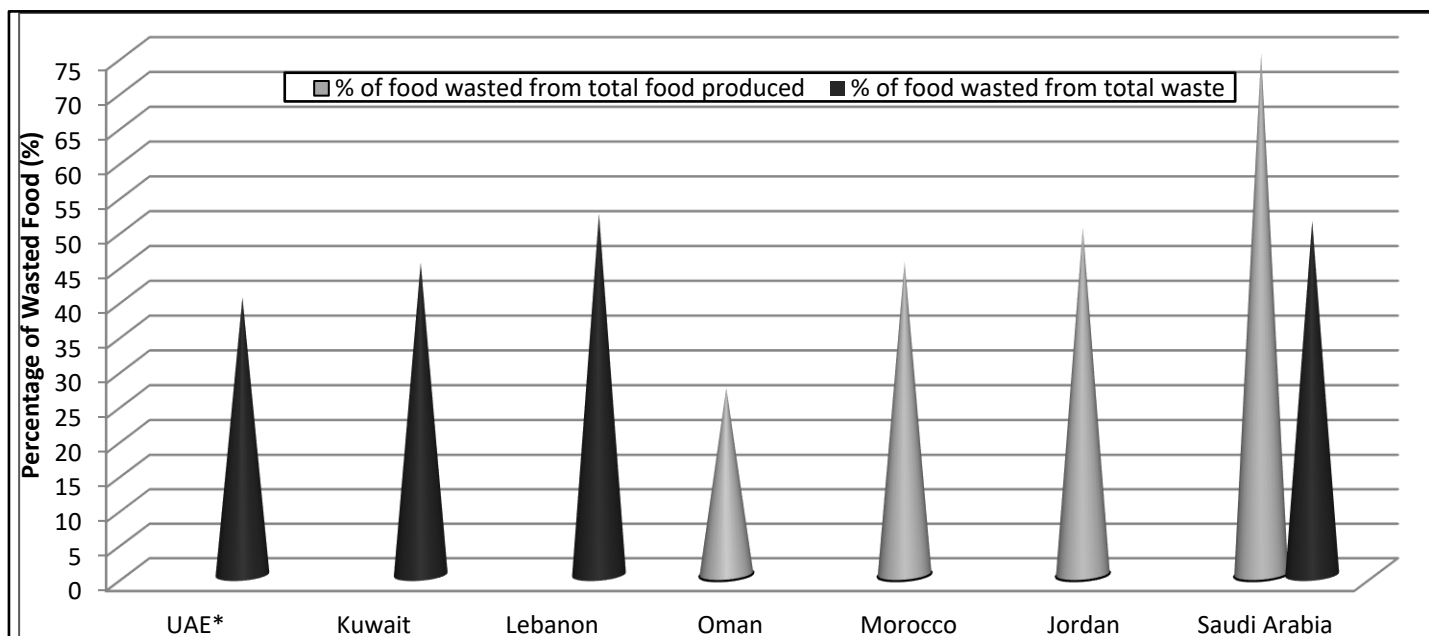


Figure 6. Percentage of the amount of food wasted from total food produced and from total waste in various Arabic-speaking countries.

* UAE: United Arab Emirates.

Additional risk factors are food choices and consumption (Abdelradi, 2018), hot climate (The Borgen Project, 2017), and laws that force food-outlets to dump

unconsumed foods (Al Shaibany, 2017). Food overproduction also contributed to food waste in Kuwait (Ismail, 2015). Food loss also occurs throughout the food

supply chain (planting, harvest, production, storage, or distribution) which happened in Algeria (Baghdad, 2019; El Bilali, 2018), Yemen (The Free Library, 2013), and Tunisia (El Bilali, 2018).

Tunisians dumped most of the bread served at college cafeterias (93%) (FAO, 2018c) and in 281 households (81.5%) (Capone *et al.*, 2016). In Egypt, 15% of cereals (Di Terlizzi *et al.*, 2016) and 45-55% of fruits and vegetables (Capone *et al.*, 2016; FAO, 2015a; USAID, 2019a) produced are lost. In Palestine, each year about 5.6 and 3 thousand tons of cucumber and tomatoes are squandered, respectively (Garrone *et al.*, 2017). Therefore, laws should be applied to limit food squander during food production.

During Ramadan, food disposal is exceptional. For example, Algerians threw away 3%, 5%, and 8% of breadsticks, vegetables, and milk purchased in Ramadan, respectively (Capone *et al.*, 2016). In Bahrain, the daily amount of food that ends in landfills in Ramadan equals 600 tons (Trade Arabia: Business News Information, 2015), which is greater than the quantity dumped on a non-fasting day (400 tons) (BMMI Group, 2016). Similarly in Jordan, the daily amount of food waste generated during the Holy month is larger than in a regular day by 600 tons (J. T. 2017). Furthermore, in Kuwait (Arab Times, 2017), Qatar (Abiad and Meho, 2018; Zafar, 2019), Saudi Arabia (Abiad and Meho, 2018), and the UAE (Abiad and Meho, 2018; The Times of India 2014), the lost food formed 30-50% of total waste in Ramadan (Arab Times 2017). This is disappointing especially since the post-feast food can nourish about 250 individuals (Abiad and Meho, 2018). Hence, awareness campaigns should be carried out to educate people about the appropriate practices of food purchase, preparation, and storage.

Solutions for Food Insecurity and Food Loss

The suggested solutions for food insecurity and food loss in the Arab World consist of: development of

agricultural projects that increase food availability; improvement of food production chain via enhancing agriculture systems (Malkawi, 2017; Dhaou, 2016; FAO NENA, 2016; FAO, 2015a) (Bencivenni, 2017; Garrone *et al.*, 2017) (FAO, 2015b; Sabones, 2015) and fishing (FAO, 2015c; FAO, 2015d); desalination of seawater, and building dams and green-houses (Fiaz *et al.*, 2018; The UAE Government, 2019); planting forest trees to prevent soil erosion; supporting cultivation via supplying farmers with tools and seeds, and improving irrigation technologies (FAO, 2019c; FAO, 2018d); raising lands use and reducing agricultural exports (Leon, 2016; Hicks, 2015) (Saidi and Diouri, 2017); use of biotechnology to boost crop productivity and nutrition quality, and its resistance to drought and pests; building storage and processing facilities; using refrigerated transport vehicles; adoption of food-waste reduction technologies such as Food Watch (Department of Dubai, 2019) and Winnow (Burger, 2018); and environmentalists and legislators should work together to develop new regulations or change the old ones, to limit food disposal (Georgetown University in Qatar, 2018; Gulf Times, 2018; Suresh, 2019) and encourage food donation (via tax reduction for donors).

Other original solutions include developing a double-sided card to be used in restaurants where a greenside indicates acquiring leftovers, and a red one declining them. This technique reduced food waste by 26% (Nudge Lebanon, 2019). The Egyptian government created a smart card, allowing customers to gain points on not obtained foods; hence decreasing food loss (Di Terlizzi *et al.*, 2016). The Saudi government and I'm also established a prize for restaurants with the least food waste (Arab News, 2018), and penalized those that dispose of food (GDN Online, 2018). Oman on the other hand built a biogas machine to recycle food waste and generate electricity (Al Maqhusi, 2018). All Arabic-speaking countries should follow these methods to

abolish food insecurity via deflating food waste and increasing food sustainability.

Food Redistribution

The food reallocation concept could diminish the gap between food waste and insecurity. This approach, which several international and local programs adopted, is common in the Arab world except in Comoros as displayed in **Figure (7)**. Food donation, rescue and/or redistribution agencies were widespread in Jordan (Abu Tair, 2016; ACTED, 2018; Action Against Hunger - Jordan, 2019; Atiyeh, 2017; CARE, 2017; Caritas Jordan, 2019; Collateral Repair Project, 2017; ETAAM for Training and Development, 2019; IRC, 2019; Islamic Relief, 2019; Islamic Relief USA, 2019a; Mahboubbeh, 2018; Nabulsi, 2019; Nabulsi, 2015; Smadi, 2015; RHAS, 2019; Tkiyet Um Ali - Food for life, 2019; UNHCR, 2013; World Renew, 2014; WFP, 2018a), Yemen (ACTED, 2018; Action Against Hunger - Yemen, 2019; Charity Watch, 2018; Cogan, 2018; Holohan, 2018; Human Appeal, 2018; IRC-Yemen, 2019; Islamic Relief USA, 2019a; Launch Good - Build an Inspired Future, 2019; Palin, 2017; Relief Web, 2018a; Save the Children, 2019a; USAID, 2019b; WFP, 2019e; World Help, 2019; Yemeni Food Bank, 2019), and Syria (ACTED, 2018; Action Against Hunger in Syria, 2019; Cook, 2017; IRC, 2019a; Islamic Relief USA, 2019a; Mercy Corps, 2019; NRC, 2019; Relief Web, 2018a; Rise Against Hunger, 2019; Sputnik News, 2018; Trócaire, 2019; USAID, 2019c; WFP, 2019f; World Renew, 2014). This high number of agencies assists the governments in accommodating the hosted refugees and encountering the traumatic war consequences. Nevertheless, regardless of the efforts in Syria and Yemen, almost half of Syrians (USAID, 2019c), and ~ 3.4 million Yemenis (WFP, 2019g) still need assistance. Not to mention that health conditions in Yemen have worsened due to the militias who stole food boxes from distribution locations or blocked the caravan march, preventing rations from

reaching the disadvantaged (PBS News Hour, 2018). Thus, maintaining sustainable access to donations is vital to nourish the starving and prevent hunger deaths.

Other war-zone areas only had numerous philanthropic organizations ($n < 10$) despite their indispensable role in relieving the unfortunate (**Figure-7**). These include Djibouti (CARE Learning Tours Program, 2015; NRC, 2019; UN, 2017; USAID, 2019d; USAID, 2019e; WFP, 2019b), Iraq (ACTED, 2018; Action Against Hunger - Iraq, 2019; Human Relief Foundation, 2019; Islamic Relief USA, 2019a; Knights of Columbus, 2015; KSIMC, 2015; KSIMC, 2013; USAID, 2018a; WFP, 2019h), Libya (ACTED, 2018; ANSA, 2019; Helping Hands, 2019; Save the Children, 2019b; WFP, 2017a), Mauritania (Action Against Hunger - Mauritania, 2019; Financial Tracking Services, 2016; Relief Web, 2013; USAID, 2018b), Palestine (ACTED, 2018; Action Against Hunger - West Bank, Gaza 2019; AlWatan Voice, 2015; Insan Online, 2012; Islamic Relief USA, 2019a; Suleiman, 2008; UNRWA, 2011; WFP, 2019i; Zayed, 2015), Somalia (ACTED, 2018; Action Against Hunger - Somalia, 2019; Coghlan, 2011; ICRC, 2018; Kimani, 2018; The Global Foodbanking Network, 2019; OCHA, 2019a; WFP, 2019j; UNICEF, 2019; USAID, 2019f), and Sudan (ACTED, 2018; Action Against Hunger - South Sudan, 2019; Awad, 2018; IRC, 2019b; Relief Web, 2019; Sudanese Food Bank Organization, 2014; OCHA, 2019b; OCHA, 2019c; UNICEF, 2018b; USAID, 2019g). Thus, development of local is essential in promoting both food production and reallocation to ensure food sufficiency in such torn areas.

Food donation agencies were modestly present ($n= 1-10$, **Figure-7**) in Algeria (Algerian Food Bank, 2016), Morocco (Banque Alimentaire, 2018; Zero Hunger, 2019), Egypt (FAO, 2019a; Islamic Relief USA, 2019b; Egyptian Food Bank, 2019; WFP, 2013; WFP, 2019a), Qatar (Eid Charity, 2019; Khatri, 2017; Murad, 2019; Qatar Charity, 2019; Wa'hab, 2017), Saudi Arabia (AlFozan Social Foundation, 2017; Ita'am- Saudi Food

Bank, 2019; Khiyrat Association for Saving Food, 2018), Kuwait (Al-Khalidi, 2017; Kuwait Food Bank, 2017; Re: Food, 2019), Oman (Dar Al Atta'a, 2016; Hasan, 2016; Oman Charitable Organization, 2011; Y-Pulse of Oman, 2016), Tunisia (Essahafa, 2011; Human Plus, 2019; Islamic Relief USA, 2019c; WFP, 2018d; WFP, 2019k), Bahrain (El-Asm, 2013; Feed the Need, 2017; Mums in Bahrain, 2015; Global Foodbanking Network, 2019; Trade Arabia: Business News Information, 2017), the

UAE (Dhal, 2013; Ro'yati, 2019; Saseendran, 2017; The UAE Government, 2019), and Lebanon (ACTED, 2018; Di Terlizzi *et al.*, 2016; Food Blessed, 2016; Ibrahim *et al.*, 2019; Islamic Relief USA, 2019a; Lebanon Food Bank, 2019; Relief Web, 2017; Save the Grace, 2019; USAID, FAO, iMMAP, 2015; World Renew, 2014). This humble number of such agencies is not clear and worth examination.

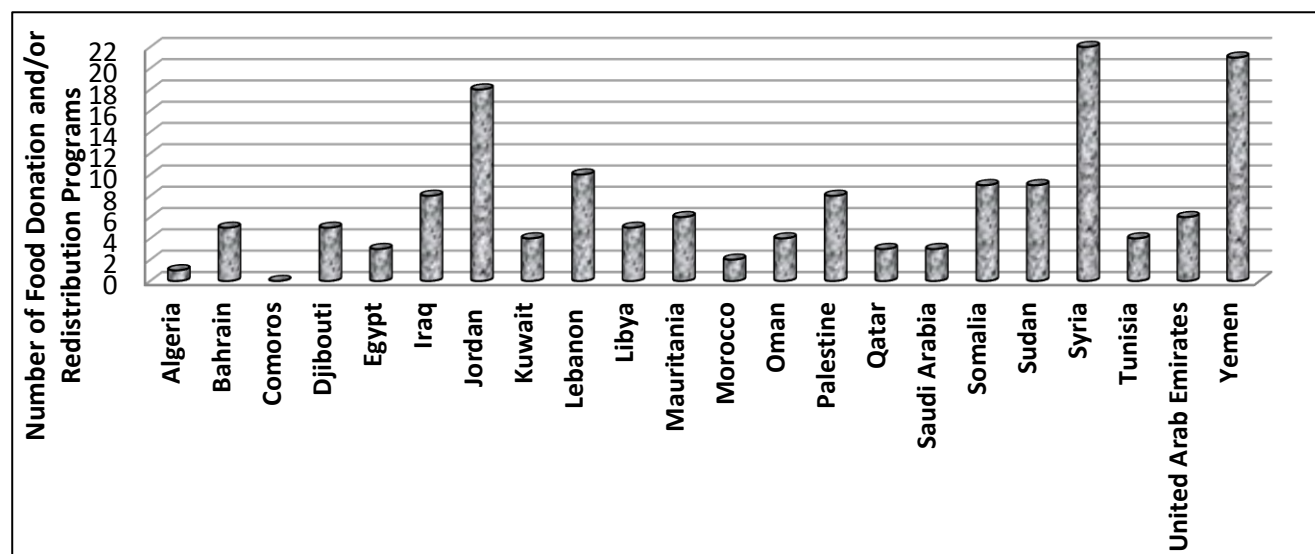


Figure 7. Number of food donation and/or redistribution programs across the Arab world.

Some Arabs established innovative food redistribution practices. For example, Ezwitti is a bistro in Jordan that invites customers to buy an extra meal/sandwich for the needy (Nabulsi, 2019; Nabulsi, 2015). Moreover, a Saudi Samaritan (Nitz, 2014), the UAE Food Bank (Al Bayan, 2019; Al Bayan, 2018; Al-Katbi, 2019; The UAE Food Bank, 2019), and Hefth Al-Ta'am (saving food) and Hefth Al-Ne'me (saving the blessing) Kuwaiti programs (Al-Kahlout, 2016; Al-Khalidi, 2017) placed fridges in various neighborhoods. Moreover, a Saudi Samaritan (Nitz, 2014), the UAE Food Bank (Al Bayan, 2019; Al Bayan, 2018; Al-Katbi, 2019; The UAE Food Bank, 2019), and Hefth Al-Ta'am (saving

food) and Hefth Al-Ne'me (saving the blessing) Kuwaiti programs (Al-Kahlout, 2016; Al-Khalidi, 2017) placed fridges in various neighborhoods. These refrigerators then are filled with surplus food that can be consumed by the poor. Another modern way was inventing an environment-friendly fridge in Morocco (Hanes, 2018). Friendly refrigerator is a pot of three layers (i.e.; clay; sand; and food) covered by a cloth and kept in a breezy area. Individuals must water the middle film 1-2 times/day to keep the food temperature lower than the external temperature by 6-degree. This cheap method reduces food deterioration (Hanes, 2018). Hence, these low-cost techniques reduce food disposal and save people

from begging for food via facilitating food availability to whoever cannot afford it.

Strengths and Limitations

The first limitation is the lack of financial support and the use of only 36 peer-reviewed papers which is due to insufficient research in the Arab world. Secondly, most of the studies were cross-sectional; nevertheless, to confirm their findings, large cohort surveys are required. Third, none of the review articles was a meta-analysis. Lastly, very few studies actumeasured the amount of wasted food. Hence, future investigations should estimate the actual quantity of food consumed and remaining on the plate. On the other hand, this is the first systematic review that discussed food security, food waste, and food redistribution in Arabic-speaking countries. This document also used Arabic and English publications and included a personal interview, research articles, systematic reviews, organization reports, and newspaper articles.

Conclusions and Recommendations

This review establishes a database for researchers regarding hunger and food insecurity in the Arab world, affecting almost one-fifth of it. Famine and malnutrition are the greatest challenges that Iraqis, Libyans, Mauritians, Palestinians, Syrians, Somalis, Sudanese, and Yemenis are facing. Thus, these nations are in urgent need of assistance to aid the starving and displaced persons to manage the miserable conditions of war and poverty. These two issues combined with the harsh

climate conditions and limited agricultural resources are suggested to induce food insecurity and hunger. Yet additional research must be conducted to discern the main reasons for food insecurity in each state, particularly the role of socioeconomic status. Another probable cause for the lack of food security is food disposal, where one-third of food ends in landfills; this relationship nonetheless deserves further investigation. This finding is alarming especially since millions of Arabs are suffering from undernourishment. Hence, the development of solutions to reduce food loss is critical. At the national level improvement of agriculture and food supply chain conditions; enforcement of laws to encourage food donation and penalize food waste, increasing awareness regarding food waste and insecurity, and creating jobs via developing sustainable long-term projects should be implemented. At the personal level, consumers should write a shopping list, prepare food according to the family size, store food/meals in proper conditions, or donate the extra food. The latter behavior is widespread in the Arab World. Moreover, food salvage and redistribution to feed low-income people is better than discarding it when they go through dumpsters to find food or beg on the streets. This assumption therefore may diminish the gap between food waste and both hunger and food insecurity, which must be examined. Finally, prospective research should assess food insecurity and food loss in Comoros, Djibouti, Libya, Mauritania, Somalia, Sudan, and Syria.

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انعدام الأمن الغذائي وهدر الغذاء وإعادة توزيع الغذاء بين البلدان الناطقة بالعربية: مراجعة منهجية

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ملخص

أكثر من 20% من العرب يعانون من انعدام الأمن الغذائي. ما يقرب من ضعف الرقم العالمي (10.9%). كما أن سوء التغذية هو التحدي الأكبر الذي تواجهه الأمم التي تعاني من الصراع، على الرغم من وجود العديد من الوكالات التي تعيد توزيع فائض الغذاء على الفقراء. ومع ذلك، فإن هذا المجتمع يهدر 34% من طعامه. لذلك، فإن الهدف من هذه الورقة هو مناقشة انعدام الأمن الغذائي وهدر الغذاء وإعادة التوزيع في 22 دولة ناطقة باللغة العربية. الحرب والفقر والظروف المناخية القاسية والموارد الزراعية المحدودة والتخلص من الغذاء هي عوامل الخطر الأخرى لانعدام الأمن الغذائي. ومع ذلك، فإن إعادة توزيع الغذاء من شأنه أن يساعد في تقليص الفجوة بين هدر الطعام وانعدام الأمن، الأمر الذي يستحق مزيداً من البحث. تشمل الحلول الأخرى تطوير المشاريع الزراعية؛ تحلية مياه البحر و / أو بناء السدود؛ استخدام التكنولوجيا الحيوية لتعزيز إنتاجية المحاصيل وجودة تغذيتها ومقاومة الجفاف والآفات؛ اعتماد تقنيات الحد من هدر الغذاء؛ ووضع لوائح / قوانين جديدة من خلال تخفيض الضرائب للمانحين وعرض غرامات إهدار الطعام. أخيراً، تختلف المراجعة الحالية عن المخطوطات المنشورة الأخرى من حيث أنها تنشئ قاعدة بيانات للباحثين فيما يتعلق ليس فقط بهدر الطعام، ولكنها تصف أيضاً الأسباب والحلول المقترحة للحد من الجوع وانعدام الأمن الغذائي في العالم العربي.

الكلمات الدالة: البلدان الناطقة بالعربية، انعدام الأمن الغذائي، إهدار طعام، إعادة توزيع الغذاء.