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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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 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.
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).
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.

<table>
<thead>
<tr>
<th>Country</th>
<th>Goal</th>
<th>Data collection method</th>
<th>Reference, year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>Estimation of household food waste in Algeria</td>
<td>An online survey conducted over 2 months and assessed 323 residences</td>
<td>Arous et al., 2017</td>
</tr>
<tr>
<td>Egypt</td>
<td>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</td>
<td>Online survey and face-to-face interviews with a random sample of 181 adults over 4 months</td>
<td>Abdelradi 2018</td>
</tr>
<tr>
<td>Egypt</td>
<td>Measurement of solid waste generated from an economy class in-flight</td>
<td>12 Egypt Air-flight representatives</td>
<td>Elmenofi et al., 2015</td>
</tr>
<tr>
<td>Iraq</td>
<td>Evaluation of the quantity and monetary value of wasted grain products in restaurants in Erbil</td>
<td>Survey of 50 randomly selected restaurants</td>
<td>Jamil et al., 2016</td>
</tr>
<tr>
<td>Iraq</td>
<td>Quantification of the generated household waste and its composition in Karbala</td>
<td>Analysis of 70 households waste over winter and summer from 35 districts</td>
<td>Al-Mas'udi and Al-Haydari, 2015</td>
</tr>
<tr>
<td>Iraq</td>
<td>Solid waste chemical composition in Baghdad</td>
<td>2520 samples collected within 6 months</td>
<td>Abd Al-Kareem, 2014</td>
</tr>
<tr>
<td>Iraq</td>
<td>Analyze kitchen food waste at the household level and its determinants in Baghdad</td>
<td>Collected data from 20 families using a survey over 8 months</td>
<td>Al-Maliky and ElKhayat, 2012</td>
</tr>
<tr>
<td>Iraq</td>
<td>Assessment of physical and chemical composition of household waste in Mosul</td>
<td>Analyzed 1680 waste samples collected during 6 months</td>
<td>Al-Rawi and Al-Tayyar, 2012(a)</td>
</tr>
<tr>
<td>Iraq</td>
<td>Determination of household waste generation and composition in Mosul</td>
<td>Face-to-face survey of households in selected districts, and examining 252 household waste samples</td>
<td>Al-Rawi and Al-Tayyar, 2012(b)</td>
</tr>
<tr>
<td>Iraq</td>
<td>Behavioral assessment of household solid waste management, and estimation of the quantity and composition of the generated waste in Al-Kut</td>
<td>Surveying 80 households accompanied by collecting household waste samples over 7 months</td>
<td>Sulaymon et al., 2010</td>
</tr>
<tr>
<td>Iraq</td>
<td>Measurement of the composition and characteristics of the generated household waste in Nassiriayah</td>
<td>A sample of 65 households was recruited from 3 districts to analyze their waste</td>
<td>Yasir and Abudi, 2009</td>
</tr>
<tr>
<td>Jordan</td>
<td>Evaluation of food security of house-holds of Jordanians living in Northern Badia</td>
<td>Interviewed 200 heads of families from 26 villages for 2 months</td>
<td>Abuamoud et al., 2016</td>
</tr>
<tr>
<td>Jordan</td>
<td>Assessment of plate waste in Amman</td>
<td>A sample of 600 university students filled out a self-administered questionnaire during one academic year</td>
<td>Al-Domi et al., 2011</td>
</tr>
</tbody>
</table>
Table 1. Continued.

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

* A symposium research paper.
** A conference research paper.
Table 1. Continued.

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Saudi Arabia</td>
<td>Quantification of the amount of food served and wasted during a pilgrimage in Makkah</td>
<td>245 pilgrims were surveyed</td>
<td>Amara et al., 2013</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Chemical Analysis of the composition of food plate waste in Riyadh</td>
<td>A 6-day survey collected data from 90 university students, accompanied by chemical composition analysis of food waste for 60 plates</td>
<td>Al-Othman and Hewedy, 1996</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>As of the monetary value of the edible food plate waste in selected hospitals in Riyadh</td>
<td>In 18 hospitals, estimation of plate waste was performed for 6 consecutive meals over a period of 2 days, via surveying 554 patients and 205 attendants</td>
<td>Alshoshan, 1992</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Discussion of food was a serious threat to food sustainability and security</td>
<td>A systematic review of 54 reports</td>
<td>Baig et al., 2019(a)</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Addressing food waste effect on food security</td>
<td>A review of 10 reports</td>
<td>Baig et al., 2019(b)</td>
</tr>
<tr>
<td>Tunisia</td>
<td>Documentation of household food waste in Tunisia</td>
<td>A population sample of 281 adults was interviewed in 2 months</td>
<td>Sassi et al., 2016</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>Evaluation of the generated household food waste and its composition</td>
<td>A 3-week survey collected 840 samples of food waste from 40 houses</td>
<td>Abu Qdais et al., 1997</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>Estimation of the food waste through the foodservice chain, and exploration of the causes and steps of food waste generation in the hospitality industry</td>
<td>Surveying 45 hotels and restaurants</td>
<td>Pirani and Arafat, 2016</td>
</tr>
<tr>
<td>More than one country</td>
<td>Evaluation of the effect of urbanization on food security, poverty, and health in Amman (Jordan) and Manama (Bahrain)</td>
<td>Comparing food security factors, poverty, and urbanization of Amman with these of Manama using the FAO Food Insecurity and Vulnerability Information and Mapping Systems</td>
<td>Galal et al., 2010</td>
</tr>
<tr>
<td>Mediterranean Arab states</td>
<td>Investigation of waste of bread and bakery products in Algeria, Egypt, Lebanon, Morocco, and Tunisia</td>
<td>An online survey completed by 1,122 adults within a 4-month duration</td>
<td>Capone et al., 2016</td>
</tr>
</tbody>
</table>
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 Mauritanians, 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-Ismail et al., 2010; Bissada, 2017), followed by the UAE (8%) (Abu-Ismail 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-Ismail 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 lost 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 ≥ 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; 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

![Figure 5a](image)

* UAE: United Arab Emirates.

![Figure 5b](image)

* UAE: United Arab Emirates.
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 Nasseri, 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.

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
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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; Mahboubeh, 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, 2019a; 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, 2019b), 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, 2019a; Zayed, 2015), Somalia (ACTED, 2018; Action Against Hunger - Somalia, 2019; Coglan, 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. 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 starving.
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 actumereasured 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, Mauritanians, 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, Mauritanian, Somalia, Sudan, and Syria.

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

تمارا موسى

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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 الأمة 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 لأمراض الأغذية. ومع ذلك، فإن إعادة توزيع الغذاء من شأنه أن يساعد في تقليص الفجوة بين هدر الطعام وإعادة الأمن الغذائي. الأمر الذي يحقق مزيدًا من البحث. تشمل الحلول الأخرى تطوير المشاريع الزراعية: تحلية مياه البحر و / أو بناء السدود؛ استخدام التكنولوجيا الحيوية لتعزيز إنتاجية المحاصيل ووجود غذاء خالي من الديدان؛ اعتماد تقنيات حماية المجتمعات من هدر الغذاء؛ وضع قواعد على استراتيجيات للمناصرين وفرض غرامات إهدار الطعام. أخيرًا، تختلف المراجعة الحالية عن المخطوطات المنشورة الأخرى من حيث أنها تتشكل قاعدة بيانات للباحثين فيما يتعلق ليس فقط بإهدار الطعام، ولكنها تصف أيضًا 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.