

DETERMINANTS OF FOOD INSECURITY IN TUNISIA'S LABOR FORCE DURING THE UKRAINE-RUSSIA CONFLICT: A COMPARATIVE ANALYSIS

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Abstract

The Russia-Ukraine conflict, which began in February 2022, has severely disrupted global wheat supply chains, with significant repercussions for food security in import-dependent countries like Tunisia. This study investigates the war's Determinants on food insecurity levels among Tunisia's labor force, aged 25–54, using the Food Insecurity Experience Scale (FIES). Focusing on employment status, gender, region (urban vs. rural), and income level, the research examines food insecurity trends across three periods: pre-war (18 months before February 2022), the first 18 months of the war (February 2022 – July 2023), and the subsequent 18 months (August 2023 – January 2025). Survey data from 166 respondents reveal significant disparities: unemployed individuals experienced universal food insecurity (100%) during and after the war, while employed individuals showed partial recovery. Gender disparities emerged in the post-war period, with women facing higher food insecurity rates (49.55%) compared to men (23.81%). Regional differences were also pronounced, with rural areas exhibiting lower food insecurity than urban areas. These findings highlight the disproportionate impact of the war on vulnerable populations and underscore the need for targeted interventions, such as employment programs, gender-sensitive policies, and regional food security initiatives, to mitigate long-term food insecurity in Tunisia.

Keywords: food insecurity scale FIES, Tunisia, labor force, Russia-Ukraine war, employment status
JEL: J17, J21, J31, Q56

Introduction

The Russia-Ukraine conflict, beginning in February 2022, has severely disrupted global food supply chains, particularly for wheat—a staple in many countries. Tunisia, which imports approximately 70% of its cereal needs, has been significantly impacted (African Development Bank, 2022, p. 4), as Ukraine and Russia historically supplied over 50% of its wheat (Gannoun, et al., 2024). Rising prices and export restrictions have exacerbated food insecurity, particularly among Tunisia's labor force, where employment status directly influences household food access and economic resilience.

Tunisia's reliance on cereal imports, coupled with domestic challenges such as droughts and economic instability, has heightened vulnerability to external shocks. The labor force, especially individuals aged 25–54, faces increased risks of food insecurity due to rising costs and limited income buffers. Regional and socioeconomic disparities further complicate the issue, with rural and low-income households disproportionately affected.

This study addresses a critical gap in understanding how geopolitical conflicts and economic disruptions impact food insecurity at the household level, particularly in labor-dependent economies like Tunisia. By examining these dynamics, the research aims to inform targeted interventions to mitigate the long-term effects of the conflict on food security.

Literature Review

The Russia-Ukraine war has exacerbated global food insecurity, building on existing weaknesses in the international food system. In 2021, at least 155 million people in 10 countries faced severe food insecurity, with eight of those countries experiencing armed conflict. (Grebmer, et al., 2021 , p. 3). A study conducted by (Mottaleb, et al., 2022) using data from 163 countries (2016-2019) indicates that a 1% decrease in global wheat trade could increase wheat prices by 1.1%, leading to a 0.59% reduction in yearly per capita wheat consumption and a 0.54% decrease in daily calorie intake. The study suggests that a 50% reduction in wheat exports from Russia and Ukraine could raise wheat prices by 15%, reducing wheat consumption and dietary energy intake by at least 8%⁸. To avoid a food crisis, the study recommends improving domestic wheat production and expanding wheat cultivation in Africa, East Asia, and South America, with international agencies supporting wheat research and development.

Tunisia is heavily reliant on imported grains, with wheat constituting a substantial portion of these imports. Approximately 95% of the soft wheat used in Tunisia, primarily for bread production, is sourced from abroad, mainly from Ukraine and Russia. In fact, Ukraine alone accounts for about 40% of Tunisia's wheat imports (Akademiya, 2023, p. 2). North African countries (Algeria, Egypt, Libya, Morocco, and Tunisia) import 80% of all wheat in Africa. Russia supplies 32% and Ukraine 12% of the total wheat imports to the continent (Ulimwengu, 2023).

The Russian invasion of Ukraine in 2022 led to a global wheat price spike and food insecurities in import-dependent countries. International cooperation through initiatives like the Black Sea Grain Initiative and the removal of export restrictions may have mitigated the 2022 price hike by 13 percentage points. In a worst-case scenario with harvest failures, export restrictions, and blocked Ukrainian exports, wheat prices could have increased by 90% compared to the 2000–2020 average. Countries most reliant on Ukrainian wheat and experiencing substantial impaired supply include Tunisia, with a –44.1% drop compared to a factual change of –13.2% (Kuhla, et al., 2024).

Prior to the war in Ukraine, Tunisia already faced a challenging food security situation. More than 1.5 million Tunisians (12.6% of the population) experienced moderate to severe food insecurity (Habib, 2024). Tunisia relies heavily on imports to cover 95% of its soft wheat and 70-75% of its barley consumption. Between 2017 and 2021, Tunisia imported an average of 2.4 million tons of grain annually. Public debt increased substantially over the past years to over 80 percent of Gross Domestic Product (GDP) and is unsustainable without an IMF program (International bank for reconstruction and development, 2022, pp. 6-9-6).

In 2023, Tunisia's imports of wheat and meslin totalled \$792 million, a 10.8% decrease compared to \$888 million in 2022 (Trend Economy, 2023). Cereal import needs for the 2023/24 marketing year are projected to reach 4 million tonnes, roughly 30% higher than the previous year's average (FAO, 2023). The total cereal production in Tunisia for 2023 is projected to be 520,000 tonnes, roughly 70% less than the five-year average (FAO, 2024). For the year 2024/25, wheat output is projected to be 1.25 MMT, while imports are estimated at 1.8 MMT (FAS Tunis, 2024, p. 2).

The Tunisia Food Security Emergency Fund report from June 2022 notes that Tunisia faces challenges in food security due to rising commodity prices and political instability (UNSDG, 2022). The Tunisian government has multiple subsidy mechanisms to assist its agriculture, such as input subsidies, price support, credit subsidies, and irrigation subsidies. The National Strategy for Food and Nutrition Security (NSFNS) was adopted in 2015 to improve access to safe and nutritious food and includes measures such as promoting school feeding programs and strengthening social safety nets (Nawaiseh, n.d.)

In 2023, Tunisia's GDP stood at roughly \$48.53 billion, accounting for about 0.05% of the worldwide economy, as reported by the World Bank (Trading Economics, 2024). The GDP growth rate decreased to 0.4% in 2023, mainly because of unfavorable agricultural conditions and diminished domestic demand, while inflation hit 9.3% in that year (African development bank group, 2024). Forecasts suggest that Tunisia's GDP is anticipated to rise to approximately \$49.31 billion by the conclusion of 2025, with a long-term outlook predicting \$50.05 billion in 2026 and \$50.80 billion in 2027. Moreover, the projected GDP per capita for 2023 is around \$3,901.98 (Trading Economics, 2024).

In 2023, 25.1% of Tunisians experienced moderate to severe food insecurity, increasing from 18.2% in 2014-2016. Elevated inflation, averaging 8.5% in 2023, had a greater impact on lower-income families. A harsh drought exacerbated food-insecurity, devastating the grain yield, with the Sidi Salem dam at merely 16.7% capacity in March 2023. The nation also encountered ongoing deficits of subsidized food products such as flour, rice, and sugar (UNICEF, 2023).

A 2022 survey by the National Institute of Statistics (INS) reported that 403 TND is the monthly minimum wage (SMIG) in Tunisia for a 48-hour workweek, equating to 2.11 TND per hour. For a 40-hour workweek, the minimum wage is around 357.136 TND per month, or 2.21 TND per hour. Meanwhile, the average monthly wage in Tunisia is 924 TND. (INS (Statistique Tunis), n.d.)

As per Tunisia's National Institute of Statistics (INS), the workforce in Tunisia grew by 1.96% in 2023, totaling 4.4 million individuals. The total of employed people hit about 3.66 million (STATISTA, 2024). The unemployment rate stood at 16% during the second quarter of 2024. Nevertheless, youth unemployment (ages 15-24) rose to 41% during that time frame (Trading Economics, 2024).

Worldwide, women experience a greater rate of food insecurity compared to men. In 2021, 31.9% of females faced moderate or severe food insecurity, while 27.6% of males did. This gap is due to gender inequalities that restrict women's access to resources, education, job opportunities, and income.

Tackling these inequalities may lessen the food insecurity divide between males and females. (Annarita Macchioni Giaquinto, et al., 2024). Tunisia's demographic landscape is characterized by a total population of approximately 12.35 million people (statista, 2024). The age distribution reveals a young population of about 2.91 million individuals, accounting for 23.56% of the total, while the working-age population (15-64 years) constitutes 66.50%, numbering around 8.21 million (World Bank Group, 2023). The elderly population (65 years and over) comprises about 1.23 million, representing 9.94% of the total population (World Bank Group, 2023). The median age is of 32.9 years in 2025 (statista, 2024) and a life expectancy of approximately 75 years (Wordometer, 2025). Tunisia's population growth rate is projected at 0.58% in 2025. These demographic trends indicate that Tunisia's population is aging, with the elderly population expected to increase significantly over the coming decades (World Bank Group, 2023).

The age range of 25 to 54 is often considered the "prime working age" or "prime employment age" group. This demographic typically includes individuals who have completed their education, are established in their careers, and are in their most productive years (Valletta, 2024). In many countries, this age group is characterized by high levels of full-time employment, with most individuals working full-time (OECD, 2022). The 25-54 age range encompasses both Millennials (25-38) and Generation X (39-54), each with distinct characteristics and consumer behaviors (Malde & Sneha, 2024).

Tunisia is known for one of the highest per capita wheat consumption rates in North Africa, estimated to be 258 kg annually (Akademiya, 2023, p. 2). Wheat consumption in Tunisia is approximately 3 million metric tons each year (Intelligence, n.d.). Wheat represents about 45% of the overall calorie consumption. In 2022, Tunisia harvested 1,325,624 metric tons of wheat (Akademiya, 2023, p. 3). The study "Price Volatility and Cereal Food Security in Tunisia: Determining the Critical Threshold of Cereal Price Volatility Using the Threshold Model" by Gannoun, Liouane, and Jammali (2024) explores the impact of cereal price fluctuations on Tunisia's food security, identifying a critical volatility threshold of 4.65%, beyond which food security deteriorates significantly. The analysis, covering 1991–2021, highlights that cereals account for over 50% of Tunisia's food imports, with a cereal dependency ratio of 65.4% between 2018 and 2020. Using Hansen's (1999) threshold model, the study reveals that when cereal price volatility exceeds 4.65%, food security becomes more sensitive to macroeconomic shocks. In the high-volatility regime, a 1% increase in global cereal prices corresponds to a 0.84% rise in food security, compared to 0.46% in the low-volatility regime, suggesting price shocks may encourage domestic production or government intervention.

Macroeconomic factors play a crucial role in food security outcomes. GDP per capita, contrary to expectations, has a negative correlation with food security, with the high-volatility regime showing a particularly strong effect (-5.46), indicating that rising incomes may lead to higher food imports and economic inequality. Inflation (CPI) has an even more severe impact, where a 1% increase leads to a 25.55% drop in food security in the high-volatility period, compared to 3.89% in the low-volatility period. Exchange rate fluctuations also contribute significantly, as a 1% depreciation in the real exchange rate results in a 6.91% decline in food security when cereal price volatility is high. External debt emerges as another key factor, with a 1% increase in debt stock leading to a 2.58% decline in food security in high-volatility periods. Surprisingly, poverty exhibits a positive correlation with food security in the high-volatility regime (17.14), possibly due to the increased effectiveness of government subsidies and social assistance programs targeting low-income groups (Gannoun, et al., 2024).

Tunisia's food security is intricately linked to its cereal sector, which constitutes over 50% of the country's food imports, highlighting the nation's heavy reliance on external supplies (Gannoun, et al., 2024). The country imports approximately 95% of its soft wheat, primarily from Ukraine and Russia, but recent geopolitical tensions have disrupted these supply chains, leading to increased import costs (Lefort, 2023). In 2022, Tunisia spent an additional \$250 million on wheat imports due to price hikes exacerbated by the Russia-Ukraine conflict (Lefort, 2023). To mitigate these challenges, Tunisia is investing in expanding its grain storage capacity through a €500 million project, aiming to double its reserves from two to four months of supply (Lefort, 2023).

The annual consumption of cereals in Tunisia amounts to over 3.4 million tonnes, with significant portions allocated to durum wheat, soft wheat, and barley (UN-HABITAT and UNECA, 2022). Efforts are underway to enhance food security through projects like the PADIDFIC initiative, which focuses on improving cereal production and supply chain resilience, which aims to increase the production by about 1.6 million quintals of durum wheat, 1.2 million quintals of barley, 18,000 quintals of vegetable oil, and 42,000 quintals of meal, with expected impact on food security (The African development bank group, 2023, p. 8). Despite these efforts, Tunisia's cereal sector remains vulnerable to external shocks and climate change, underscoring the need for sustainable agricultural policies to ensure long-term food security (World bank group, 2024).

Table 1: Cereal production, import, and export data for tunisia (2021-2024)

Cereal Type	Annual Domestic Production (million quintals)	Do-Pro (mil-tal needs)	Annual Imports (% of total needs)	Import Volume (Metric Tons, 2021)	Import Sources (2021)	Export Volume (Metric Tons, 2021)	Export Destinations (2021)
Soft Wheat	1.0 - 1.5		95%	1,800,000	Ukraine (40%), Bulgaria, Canada	2.32k	France (\$2.27k), Ireland (\$49)
Durum Wheat	0.8 - 1.4		40%	600,000	Canada, EU	Negligible	France, EU
Barley	0.9 - 1.2		67%	400,000	France, Russia	Minimal	N/A
Maize	Negligible		100%	500,000	Argentina, Brazil	N/A	N/A

Source: FAO (2023) GIEWS Country Brief on Tunisia.

Available at: www.fao.org (Accessed: 25 February 2025).

USDA (2024) Tunisia Grain and Feed Annual.

Available at: USDA Foreign Agricultural Service (Accessed: 25 February 2025).

OECD (2022) Tunisia Wheat Trade Profile. Available at: oec.world (Accessed: 25 February 2025).

In Tunisia, accessibility to food and food insecurity vary between urban and rural regions. City dwellers are more prone to experiencing significant food insecurity (68.5%) than those living in rural areas (31.5%). This is due to the fact that rural farming households gain advantages from food they produce themselves (Habib, 2024). The city of Tunis faces an unemployment rate of 18.5%, which exceeds the national average, and a poverty rate impacting 5.3% of its inhabitants. These inequalities affect the availability of nutritious food, with certain urban communities being more vulnerable to unhealthy food options. (FAO, CIRAD, RUAF, 2024, p. 2).

The Food Insecurity Experience Scale (FIES) assesses food access by using eight questions related to resource limitations (FAO, n.d.). It encompasses psychosocial and behavioral dimensions of food insecurity (GAFSP, 2018). The FIES is beneficial for evaluating populations, is simple to use, and facilitates the comparison of food insecurity rates among various nations. (FAO, n.d.)

There exist additional valuable models like the Alternative Measurement Tools: Studies on different techniques for evaluating food security, including the Household Food Insecurity Access Scale (HFIAS) that assesses household food insecurity (access aspect) using nine inquiries regarding experiences from the last 30 days, aiding in differentiating food-secure from food-insecure households (FAO, 2023). The Coping Strategies Index (CSI) assesses the actions individuals take when they are unable to obtain sufficient food. It includes a set of inquiries regarding how families deal with food shortages, examining the frequency and intensity of coping strategies, which yields a numerical score (Einstein International Center, Tufts University & TANGO, 2008).

The resilience of households to food security crises is intricate, relying on physical resources, diverse income streams, and savings (Ansah, 2021). Adaptive capacity and robust social networks are crucial in reducing adverse effects, while education, credit access, crop variety, and land ownership also bolster resilience (Ladaninezhad, et al., 2023). In the end, policies that enhance household wealth and encourage economic diversification are essential for facilitating recovery from food security (Egamberdiev, et al., 2024).

Material and method

In this paper, I have conducted a survey consisting of 44 questions. The survey is specifically designed for Tunisians who have been residing in Tunisia during the period from 18 months before the onset of the Russia-Ukraine war until January 2025. The survey is divided into four sections. The first section covers the Demographic and Economic Profile, including questions related to age, gender, professional status, monthly salary, regional area, and governorate. The second section focuses on Food Security Status and Trends. This section is divided into two parts: The first part examines Access to Wheat and Wheat Products, requiring respondents to describe their access to wheat during three distinct periods: before the Russia-Ukraine war, during the first 18 months of the war (February 2022 – July 2023), and during the most recent 18 months (August 2023 – January 2025). The second part assesses Food Insecurity Experiences using the Food Insecurity Experience Scale (FIES). This model evaluates individual food security levels across the same three time periods: the 18 months before February 2022, the first 18 months of the war, and the most recent 18 months. The third section explores Changes in Dietary Habits and Substitutes since the onset of the war. The fourth section addresses Food Waste and Storage Practices. This research paper focuses on the FIES levels of the labor force in Tunisia.

The survey was distributed primarily through social media, including Facebook, email, and WhatsApp, resulting in 166 responses. The study employs the Food Insecurity Experience Scale (FIES) to analyze the impact of professional status on food insecurity among Tunisia's labor force aged 25–54. Data analysis and hypothesis testing were conducted using Excel.

Food insecurity, defined as limited or uncertain access to adequate food, is a critical indicator of well-being during times of conflict. The war's impact on employment and food access in Tunisia is expected to disproportionately affect unemployed individuals, who lack the economic stability to mitigate food shortages. By comparing food insecurity trends among employed and unemployed individuals across three time periods, this analysis aims to provide insights into the war's socioeconomic consequences.

The analysis is based on food insecurity data spanning three distinct time periods: (1) the 18 months before February 2022 (pre-war), (2) the first 18 months of the war (February 2022 – July 2023), and (3) the post-war recovery phase (August 2023 – January 2025). The dataset includes food security levels (Food Secure, Mild, Moderate, and Severe) for employed (full/part-time) and unemployed (job seekers) individuals. Food insecurity rates were calculated as the sum of individuals reporting Mild, Moderate, or Severe food insecurity, expressed as a percentage of the total sample (166 respondents) for each employment group.

The study surveyed 166 respondents from various regions in Tunisia, focusing on individuals aged 25 to 54 in the labor force, who made up the majority of the sample (150 respondents), along with a small number of individuals younger than 25 (13 respondents) and those aged 55 and above (3 respondents). The sample was predominantly female (143 respondents, 86%), while male participants accounted for 23 respondents (14%). In terms of employment status, 96 respondents (58%) were employed, while 21 (13%) were actively seeking jobs, and 16 (10%) were unemployed but not looking for work. Additionally, 32 respondents (19%) were students, and only 1 respondent was retired.

Regarding income distribution, the largest proportion of respondents (72 individuals, 43%) reported a monthly income of more than 924 TND, while 30 individuals (18%) earned between 403 and 924 TND. A considerable number (58 respondents, 35%) reported having no income, while 6

individuals (4%) had an income below 403 TND. In terms of geographic distribution, most participants resided in urban areas (132 respondents, 80%), whereas 34 respondents (20%) were from rural areas. The survey covered multiple governorates across Tunisia, with the highest representation from Tunis (31 respondents), Ariana (17 respondents), and Ben Arous (15 respondents), while other regions had smaller but notable participation.

Key Hypotheses (Focused on Labor Force and Food Security)

H1: H_0 (Null Hypothesis): There is no significant difference in the food insecurity trends between employed and unemployed individuals across the three time periods (Before February 2022, February 2022 – July 2023, and August 2023 – January 2025).

H2: H_0 (Null Hypothesis): There is no significant difference in food insecurity trends between male and female individuals in the labor force (aged 25-54) across the three time periods: Before February 2022, February 2022 – July 2023, and August 2023 – January 2025.

H3: H_0 (Null Hypothesis): there is no significant association between regions (rural and urban) and food insecurity status (FIES score) both in the 18 months before February 2022 and during the first 18 months of the war (February 2022 – July 2023)

H4: H_0 (Null Hypothesis): There is no significant association between income level and food insecurity status (FIES score) across the three time periods: Before February 2022, February 2022 – July 2023, and August 2023 – January 2025.

Result

Food Insecurity Trends by Employment Status

Hypothesis 1:

The first hypothesis examines the relationship between employment status and food insecurity trends in Tunisia across three time periods: before the war (pre-February 2022), the first 18 months of the war (February 2022 – July 2023), and the last 18 months (August 2023 – January 2025).

The null hypothesis (H_0) states: There is no significant difference in food insecurity trends between employed and unemployed individuals across the three time periods.

The alternative hypothesis (H_1) states: There is a significant difference in food insecurity trends between employed and unemployed individuals across the three time periods.

Analysis of food security data reveals significant differences between employed and unemployed individuals:

Before the war (Pre-February 2022):

Employed individuals: 91.67% were food secure, and only 8.33% experienced any level of food insecurity.

Unemployed individuals (Job Seekers): Food insecurity was already higher at 38.10%, indicating greater vulnerability.

First 18 months of the war (February 2022 – July 2023):

Employed individuals: Food insecurity surged to 86.46%, highlighting the immediate economic impact of the war.

Unemployed individuals: Food insecurity reached 100%, meaning all unemployed respondents experienced food access difficulties.

Last 18 months of the war (August 2023 – January 2025):

Employed individuals: Food insecurity declined to 17.71%, suggesting some economic stabilization.

Unemployed individuals: Food insecurity remained at 100%, indicating that job seekers saw no recovery.

Statistical Analysis and Hypothesis Testing:

A Chi-Square Test was conducted to determine whether the observed differences in food insecurity across employment groups and time periods were statistically significant.

Before the war (18 months Pre-February 2022): $p\text{-value} \approx 1.02366 \times 10^{-12}$

Chi-Square Statistic (Calculated): 80.16

Degrees of Freedom (df): 2

Significance Level (α): 0.05

Critical Value (from the Chi-Square Distribution Table): 5.99 (for $df = 2, \alpha = 0.05$)

First 18 months of the war (Feb 2022 – July 2023): $p = 1.03356 \times 10^{-12}$

Chi-Square Statistic (Calculated): 76.69

Degrees of Freedom (df): 2

Significance Level (α): 0.05

Critical Value (from the Chi-Square Distribution Table): 5.99 (for $df = 2, \alpha = 0.05$)

Last 18 months of the war (August 2023-January 2025): P-Value: 0.00017

Chi-Square Statistic (Calculated): 17.34

Degrees of Freedom (df): 2

Significance Level (α): 0.05

Critical Value: 5.99 (for $df = 2, \alpha = 0.05$)

Since all p-values are below 0.05, we reject the null hypothesis (H_0) and conclude that there is a significant difference in food insecurity trends between employed and unemployed individuals across all three time periods. As shown in Figure 1, Cramér's V was computed to measure the effect size. The Cramér's V effect size indicates a moderate association between employment status and food security before the war (0.385), which strengthens considerably in the second period (0.701) and reaches a strong association in the most recent period (0.827).

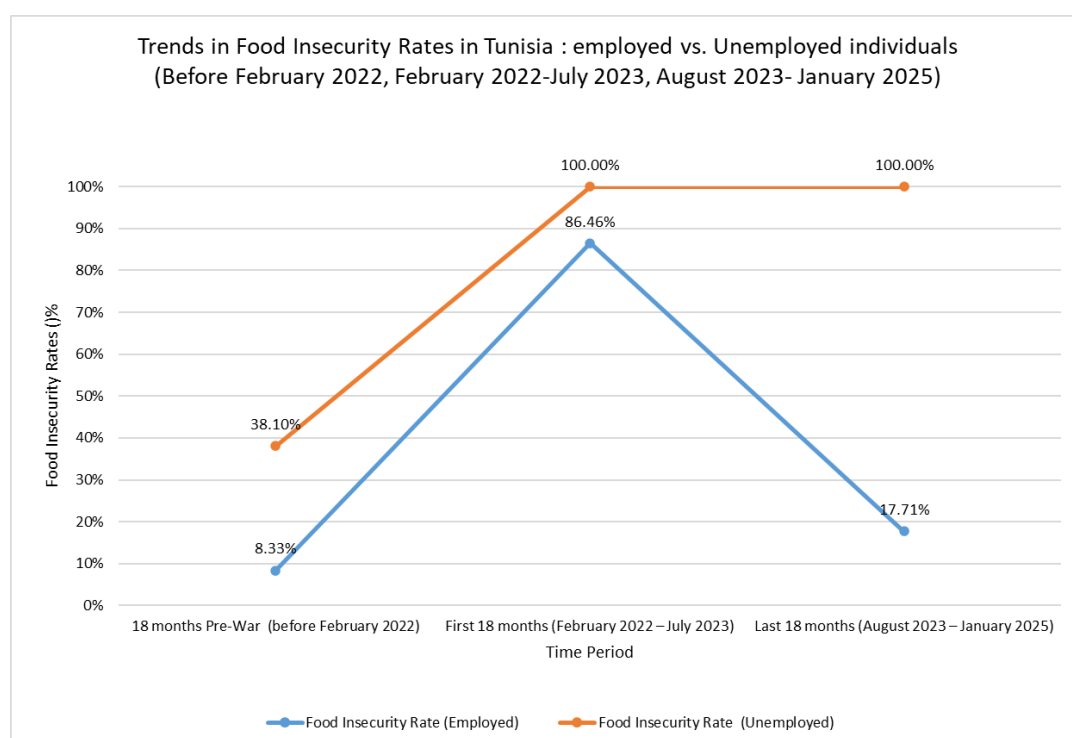


Figure 1: Trends in food insecurity rates in tunisia: employed vs. Unemployed individuals (before february 2022, february 2022-july 2023, august 2023- january 2025)

Gender and Food Insecurity Trends in Tunisia

Hypothesis 2:

This hypothesis examines the impact of gender on food insecurity trends among labor force participants in Tunisia across three distinct time periods: before the war (pre-February 2022), the first 18 months of the war (February 2022 – July 2023), and the last 18 months (August 2023 – January 2025).

H_0 : There is no significant difference in food insecurity trends between male and female individuals in the labor force across the three time periods.

H_1 : There is a significant difference in food insecurity trends between male and female individuals in the labor force across the three time periods.

Analysis of Food Security Data

Before the war (Pre-February 2022):

Female: 83.78% were food secure, with a food insecurity rate of 16.22%.

Male: 90.48% were food secure, with a lower food insecurity rate of 9.52%.

Women were slightly more food insecure than men, but the difference was not extreme.

First 18 months of the war (February 2022 – July 2023):

Female: Food security dropped drastically to 9.01%, while food insecurity surged to 90.99%.

Male: A similar trend was observed, with food security falling to 9.52% and food insecurity reaching 90.48%.

Both genders experienced a severe impact during this period, with nearly identical food insecurity rates.

Last 18 months of the war (August 2023 – January 2025):

Female: Food security recovered slightly to 50.45%, but food insecurity remained high at 49.55%.

Male: Food security improved more significantly to 76.19%, with food insecurity dropping to 23.81%.

In this period, women continued to face higher food insecurity than men, suggesting that recovery was slower for them.

Statistical Analysis and Hypothesis Testing:

A Chi-Square Test was conducted to determine whether the differences in food insecurity trends between men and women were statistically significant across time periods:

Before the war: $p = 0.1635$ (not significant)

First 18 months of the war: $p = 0.7742$ (not significant)

Last 18 months of the war: $p = 0.0328$ (significant difference)

Since the p-value for the most recent period is below 0.05, we reject the null hypothesis for the last 18 months and conclude that gender differences in food insecurity became statistically significant in this period. As shown in Figure 2, food insecurity rates among women remained higher than among men, suggesting a slower recovery for female individuals in the labor force.

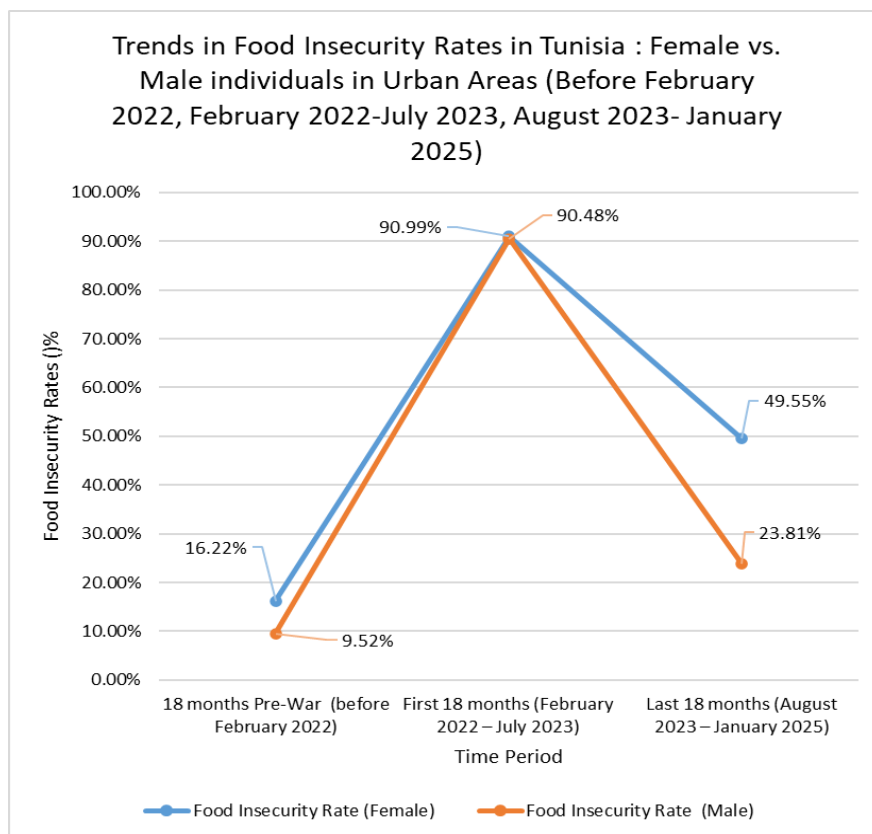


Figure 2: Trends in food insecurity rates in Tunisia: female vs. Male individuals in urban.
Association Between Region (Urban vs. Rural) and Food Insecurity Status

Hypothesis 4:

H_0 (Null Hypothesis): There is no significant association between region (urban vs. rural) and food insecurity status (FIES score) across the three time periods.

H₁ (Alternative Hypothesis): There is a significant association between region and food insecurity status across the three time periods.

This hypothesis examines the impact of regional disparities (urban vs. rural) on food insecurity trends among labor force participants (aged 25–54, employed or job seekers) in Tunisia across three distinct time periods:

Before the war (Pre-February 2022)

The first 18 months of the war (February 2022 – July 2023)

The last 18 months of the war (August 2023 – January 2025)

The Relationship Between Income Level and Food Insecurity in Tunisia

Hypothesis 4:

H₀ (Null Hypothesis): There is no significant association between income level and food insecurity status (FIES score) across the three time periods.

H₁ (Alternative Hypothesis): There is a significant association between income level and food insecurity status (FIES score) across the three time periods.

This hypothesis investigates whether income level influences food security trends in Tunisia before, during, and after the war. Respondents are categorized into three income groups:

1. Less than 403 TND
2. Between 403 TND and 924 TND
3. More than 924 TND

Analysis of Food Security by Income Level:

Before the war (Pre-February 2022):

- Higher-income individuals (More than 924 TND): 100% food secure, 0% food insecure.
- Middle-income individuals (403 TND – 924 TND): 71.43% food secure, 28.57% food insecure.
- Low-income individuals (Less than 403 TND): 100% food insecure.

Food insecurity was almost non-existent among higher-income individuals, while lower-income respondents experienced extreme vulnerability.

First 18 months of the war (February 2022 – July 2023):

- Higher-income individuals: Decline in food security, but still relatively protected.
- Middle-income individuals: Food security dropped significantly, with many shifting to mild or moderate food insecurity.
- Low-income individuals: Food insecurity persisted at nearly 100%, reflecting the economic shock of the war.

Last 18 months of the war (August 2023 – January 2025):

- Higher-income individuals: Gradual recovery in food security.
- Middle-income individuals: Partial recovery, but food insecurity remains elevated.
- Low-income individuals: Still experiencing high levels of food insecurity, indicating a lack of post-war economic relief for the most vulnerable.

Statistical Analysis and Hypothesis Testing

A Chi-Square Test was conducted to determine whether income level and food insecurity were significantly associated across the three periods:

Before the war (Pre-February 2022): $p = 1.32438\text{E-}23$

First 18 months of the war (February 2022 – July 2023): $p = 0.000185845$

Last 18 months of the war (August 2023 – January 2025): $p = 1.33505\text{E-}09$

Since all p-values are below 0.05, we reject the null hypothesis (H_0) and conclude that income level significantly influences food insecurity across all three time periods.

Income level is a critical determinant of food security in Tunisia. Before the war, lower-income individuals were already vulnerable, with 100% food insecurity in the lowest-income category. During the war, middle- and lower-income individuals experienced severe food insecurity, while higher-income individuals were relatively insulated. In the post-war period, higher-income individuals recovered faster, while lower-income groups still faced food insecurity, indicating long-term economic difficulties.

Conclusion

The findings of this study reveal significant disparities in food insecurity among Tunisia's labor force, exacerbated by the Russia-Ukraine conflict. Unemployed individuals experienced universal food insecurity (100%) during the first 18 months of the war (February 2022 – July 2023), with no recovery observed in the subsequent 18 months (August 2023 – January 2025). In contrast, employed individuals saw a sharp increase in food insecurity during the war (86.46%) but demonstrated partial recovery afterward (17.71%). Gender disparities emerged prominently, with women facing higher food insecurity rates (49.55%) compared to men (23.81%) in the post-war phase, highlighting the disproportionate impact on women in the labor force. Regional differences were also significant, with rural areas exhibiting lower food insecurity than urban areas, likely due to greater access to self-produced food. Finally, income level played a critical role, with lower-income groups experiencing persistent food insecurity across all periods, while higher-income individuals were relatively insulated.

These findings underscore the profound socioeconomic vulnerabilities exposed by the war, particularly among unemployed individuals, women, and low-income households. The study highlights the urgent need for targeted interventions, such as employment programs, gender-sensitive policies, and regional food security initiatives, to mitigate the long-term effects of food insecurity in Tunisia. By focusing on the labor force, a key demographic for household resilience this research contributes to the broader understanding of how global conflicts disrupt local food systems and exacerbate socioeconomic inequalities. Future studies should explore the long-term health, education, and economic outcomes for vulnerable populations to inform more comprehensive policy responses.

Looking ahead, the persistence of food insecurity in vulnerable populations necessitates continued monitoring and policy adaptation. Global cereal price volatility, as observed during the Russia-Ukraine war, has had a lasting impact on food affordability in Tunisia. Future disruptions in wheat and cereal markets may further strain household food security, particularly among low-income

groups. Strengthening domestic agricultural production, diversifying food import sources, and implementing long-term social safety nets will be crucial in enhancing food resilience. Future studies should explore the long-term health, education, and economic outcomes for vulnerable populations to inform more comprehensive policy responses.

Recommendation

To address the food insecurity exacerbated by the Russia-Ukraine conflict, Tunisia must implement targeted, evidence-based interventions. First, employment programs should prioritize vulnerable groups, such as unemployed individuals and youth, through vocational training, public works projects, and support for small-scale entrepreneurship. Gender-sensitive policies are essential to reduce disparities, including access to childcare, flexible work arrangements, and empowerment programs for women in the labor force. Regionally, investments in rural infrastructure such as irrigation systems and storage facilities can enhance food production, while urban areas require expanded access to affordable, nutritious food through subsidies, food banks, and community gardens. Income-based assistance, such as direct cash transfers and expanded subsidies for staple foods, should be provided to low-income households to mitigate the impact of rising prices. Strengthening social safety nets, including unemployment benefits and emergency food reserves, will offer a buffer against economic shocks. Additionally, a national food security monitoring system, using tools like the Food Insecurity Experience Scale (FIES), should be established to track trends and inform proactive policymaking. Promoting agricultural diversification, particularly for alternative crops like legumes and vegetables, can reduce reliance on wheat imports and enhance dietary diversity. Finally, international cooperation, through partnerships with organizations like the Black Sea Grain Initiative and regional collaboration with other North African countries, will stabilize food supplies and prices. These comprehensive measures will not only address immediate vulnerabilities but also build long-term resilience for Tunisia's food systems and labor force.

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