Rural-Urban Disparities in Animal-Source Food Demand and Welfare Losses During COVID-19 in Iran: A QUAIDS Approach COVID-19 and impacts on Animal-Source Food Demand and household welfare in Iran

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Abstract

The COVID-19 pandemic posed significant global challenges, including a decline in per capita income growth across all income groups in 2020. The protein sector, particularly Animal-Source Food (ASF), experienced heightened pressure on both supply and demand, leading to price volatility. This study investigates how income shocks influenced food expenditure ratios and consumption behavior, with a focus on protein-rich ASF. Using the QUAIDS model, the budget data of Iranian households, categorized by rural and urban areas for 2019 (before pandemic) and 2020 (time of COVID-19 arrival), were analyzed and compared. The findings reveal three key insights: First, the food expenditure share increased from 37% to 42%, with a more pronounced rise in rural areas. Second, positive expenditure elasticities were observed across the six ASF groups including livestock meat, poultry meat, aquatic meat, dairy products, eggs, and oils, while own-price elasticities were relatively smaller. Third, welfare losses ranging from 2% to 24.2% were identified across ASF groups, reflecting policy imbalances, supply chain inefficiencies, and unequal utility for consumers. Notably, rural areas experienced higher welfare losses in all ASF groups except for oils. The study suggests implementing price-oriented support policies for urban areas and social service-oriented measures for rural regions to address these disparities. Additionally, to enhance policy effectiveness, future research should explore the potential for substituting plant-based proteins, offering a sustainable and cost-effective alternative to mitigate the economic and nutritional impacts of future crises. These findings provide valuable insights for policymakers aiming to improve food security and economic resilience in the post-pandemic era. In order to complete the results and achieve better policies, the study should be developed in line with the possibility of substituting plant-based proteins.

Keywords: COVID-19; Animal-source food; Welfare losses; QUAIDS model; Iran

JEL Classifications: D12, Q11

1 Introduction

The outbreak of the microscopic coronavirus has presented unprecedented challenges to the global community. The disruptions caused by the pandemic have reverberated across supply chains, affecting economies at all levels of development and leaving no nation immune to the resulting fluctuations. Experts from diverse fields ranging from health and hygiene to medical, psychiatric, social, and economic domains have analyzed the multifaceted impacts of COVID-

19 and proposed strategies to address its consequences. Studies such as those by as Ahmed and Sarkodie (2021), Fan et al. (2021), and Ceylan et al. (2020) highlight significant shifts in government programs, stricter food stock management, evolving consumer purchasing behaviors, and even a notable reduction in food waste. Collectively, these studies underscore how economies underwent rapid transformations in the immediate aftermath of the pandemic's onset.

The pandemic simultaneously disrupted both the supply and demand sides of markets. On the supply side, firms faced operational pressures due to partial or total closures, labor shortages caused by quarantine measures, and financial constraints within supply chains (Aday & Aday, 2020). Qualitative and quantitative fluctuations in raw materials (Grinberga-Zalite *et al.*, 2021) and restrictions on international trade further compounded these challenges (Hayakawa & Mukunoki, 2021). Meanwhile, changes in consumer behavior such as precautionary savings, altered eating habits, and heightened concerns about food safety created short-term demand-side effects (Anderson *et al.*, 2021). These dual pressures significantly impacted food supply chains, particularly in the protein sector.

Animal-sourced foods (ASFs), integral to protein supply chains, were disproportionately affected due to their unique requirements for processing, preservation, and distribution. The increased demand for high-quality proteins, driven by their role in strengthening immune systems during the pandemic (Akaichi & Revoredo-Giha, 2014) was juxtaposed with consumer apprehensions about potential viral transmission via meat products. This paradox intensified scrutiny of ASF demand patterns. Additionally, rising production costs stemming from enhanced hygiene protocols, coupled with heightened consumer sensitivity to packaging quality and animal health, placed further strain on the protein sector. On the demand side, misinformation regarding the origins of the virus, alongside campaigns advocating plant-based diets, spurred growth in the sales of plant-based proteins (Tonsor *et al.*, 2022). Amid these challenges, ensuring adequate protein intake has become increasingly critical, particularly during the pandemic. Proteins play a vital role in bolstering immune function, preventing infections, mitigating muscle loss, and maintaining metabolic performance (Iddir *et al.*, 2020). Protein deficiency is widely acknowledged to heighten infection risks by impairing antibody production (Rodríguez *et al.*, 2011).

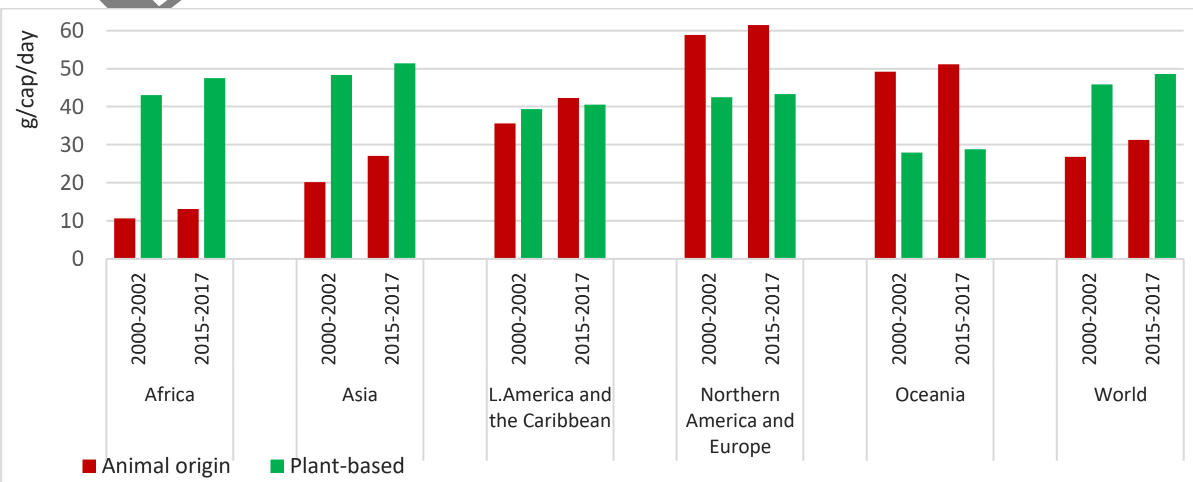

Figure 1. Average protein supply by region and origin.
Source: FAOSTAT, 09/2020 https://doi.org/10.4060/cb1329en-fig53

Globally, protein availability saw steady growth between 2000 and 2017, with developing regions outpacing the global average of 10%: Asia experienced a 15% increase, Africa 13%, and Latin America and the Caribbean 10% (FAO, 2020a) (Figure Figure 1). While plant-based proteins remain dominant in many regions accounting for 78% of protein sources in Africa and 66% in Asia the share of animal-origin proteins continues to rise worldwide, reflecting shifting dietary preferences and nutritional priorities. Animal-source foods (ASFs) are recognized as a premier source of high-quality, nutrient-rich food, particularly for vulnerable populations such as children aged 6-23 months (WHO, 2014). Their consumption is essential due to their beneficial nutrients, which support overall health and welfare. However, while protein deficiency can have severe consequences, particularly for infants, excessive ASF consumption may also contribute to adverse health outcomes (Yang *et al*., 2016). This underscores the need for balanced dietary practices that consider both the benefits and potential risks associated with ASF consumption.

1.1 The expected effect of price and income changes on ASF demand

Several factors increase the demand for protein. Estimating demand systems and understanding income and price effects are of great importance for understanding consumer preferences and predicting future consumer demand for planning purposes. A simple understanding of the role of price (P) and income (I) is possible based on Marshallian demand characteristics (X^*); The purchasing power of food is defined by (I/P), i.e. the maximum amount of food that can be purchased with income. Ernst Engel (1857) was the first to investigate the relationship between the share of food in household expenditure and income. The Engel curve shows how the demand pattern changes when household income changes (Chai & Moneta, 2010). Regarding the effect of income on food consumption, Engel said that the budget share of food ($w = X^*.P/I$) changes with the consumer's income. As income decreases, the budget share of food increases toward "1" because consumers avoid hunger and poorer households spend a larger share of their budget on food purchases. As income increases, the budget share decreases due to consumers' preference for luxury goods and the income elasticity of food also decreases (Gao, 2012). Engel's law states that as household income increases, the proportion of income spent on food decreases. Therefore, the increase in GDP per capita can form the basis for an increase in food consumption or a change in the composition of consumption. This law can also be used in welfare evaluation.

Therefore, changes in income can lead to changes in diet and substitution between staple foods and products with added value and higher protein content. The FAO reports that from 2000 to 2017, the share of ASF (in terms of weight) is 29% in high-income (HI) countries, 20% in UMI and lower- middle income (LMI), and 11% in low-income (LI) countries (FAO, 2020b). In fact, the decline in per capita income with a steep increase has reduced the consumption of ASF.

1.2 The COVID-19 shock

The COVID-19 pandemic triggered unprecedented disruptions to global economic growth, as World Bank data shows (Figure Figure 2).

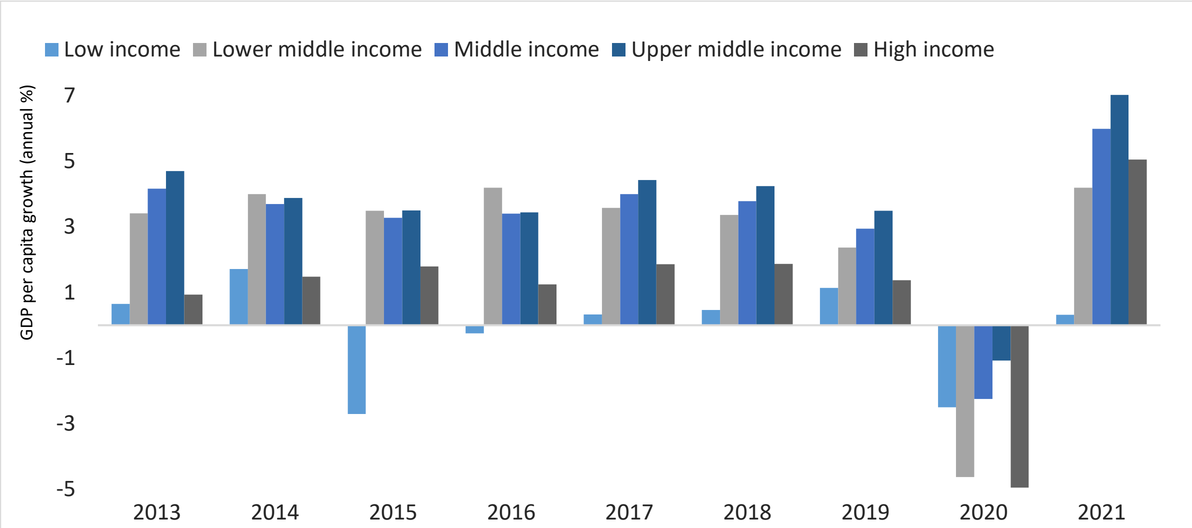

Figure 2. Annual percentage growth rate of GDP per capita based on constant local currency. Source: World Bank, 2023

In 2019, upper-middle-income (UMI) countries exhibited the highest GDP per capita growth rate, reflecting pre-pandemic economic momentum. However, the pandemic's onset in 2020 reversed this trend, with all income groups experiencing negative growth. High-income (HI) countries suffered the sharpest decline, while UMI countries were disproportionately "surprised" by the crisis despite a less severe decline, likely due to their reliance on trade-intensive sectors and limited fiscal buffers. By 2021, low-income (LI) countries achieved only marginal growth (0.3%), constrained by structural vulnerabilities and limited policy measures. In contrast, UMI economies recovered the most by capitalizing on industry resilience and adaptable supply chains. This contrast underscores the uneven distribution of recovery capacity across income tiers. Notably, LI countries' pre-pandemic growth trajectory, which started to improve in 2016, was abruptly interrupted in 2020. This reversal highlights their vulnerability to external shocks, exacerbated by inadequate healthcare infrastructure and fiscal constraints. UMI countries' initial surprise at the impact of the pandemic reflects the mismatch between their economic structures, which often depend on volatile sectors such as manufacturing, and the abrupt shifts in demand caused by the lockdowns (WorldBank, 2023).

The data emphasize the role of the pandemic as a "great disruptor" that reinforces existing inequalities. The initial greater contraction in HI countries could be due to the dominance of the service sector, which was severely affected by mobility restrictions. In contrast, UMI economies faced persistent supply chain bottlenecks despite a slower decline. These dynamics underscore the need for a tailored policy framework to increase resilience, particularly for LI and UMI countries where economic fragility remains pronounced.

2 Iran’s economy

The COVID-19 pandemic officially reached Iran on February 19, 2020, and by March 4, it had spread to all provinces. Nationwide vaccination began on February 9, 2021, but the sixth wave, triggered by the Omicron variant, continued until March 2022. The first day without a COVID-19 death was recorded on June 2, 2022. From 1987 to 2019, Iran was a lower-middle-income (LMI) country for 19 years and an upper-middle-income (UMI) country for 14 years, maintaining its UMI status since 2009 (GDP per capita: $4,046–$12,535). However, the Iranian economy faced significant challenges with growth rates of 3.8%, -4.7% and -8.2% in 2017, 2018 and 2019 respectively. Despite the continuous population growth, the national income decreased by 60%, from $444 billion in 2017 to $191 billion in 2020. Table 1 shows the economic situation of Iran in the two years of the study.

Table 1. Economic growth and inflation in Iran.

Years		GDP Annual Growth Rate (Constant 2016)	Inflation rate
2019 Before COVID-19	Q1	-6.4	4
	Q2	-2.9	6.7
	Q3	5.1	21.6
	Q4	3.8	17
2020 Arrival time of COVID-19	Q1	7.9	9.8
	Q2	6.5	10
	Q3	1	12
	Q4	3.9	10

Source: Statistical Center of Iran

Urban residents comprise 76% of Iran’s population, and rapid urbanization (Figure **Error! Reference source not found.**) has changed eating habits and increased demand for livestock products. In 2019, per capita consumption of livestock products was 133 kg, with dairy products accounting for 90% (121.08 kg) and red meat for 12.04 kg. Iran’s poultry industry, which has a 140-year history, ranks 11th and 19th in the world in terms of chicken and egg production. In 2019, the per capita consumption of chicken and eggs was 28 kg and 11 kg respectively, reflecting their importance in the Iranian food supply chain.

The COVID-19 pandemic intensified the pressure on the protein supply chain and led to price increases for ASF (Figure Figure 3). The strongest price increases were for red meat and butter, while milk, eggs, chicken and cheese increased with a delay and to a more moderate extent. Butter prices rose sharply due to Iran’s reliance on imports of semi-finished products. ASF and cereals, bread, flour and pasta account for over 53% of Iran's basket of goods, with both groups recording a slight increase in 2020. The cereals group saw the largest increase, while vegetables and pulses declined, likely due to hygiene concerns in the vegetable supply chain. The consumption of fruits and nuts increased, which can be attributed to the quarantine conditions.

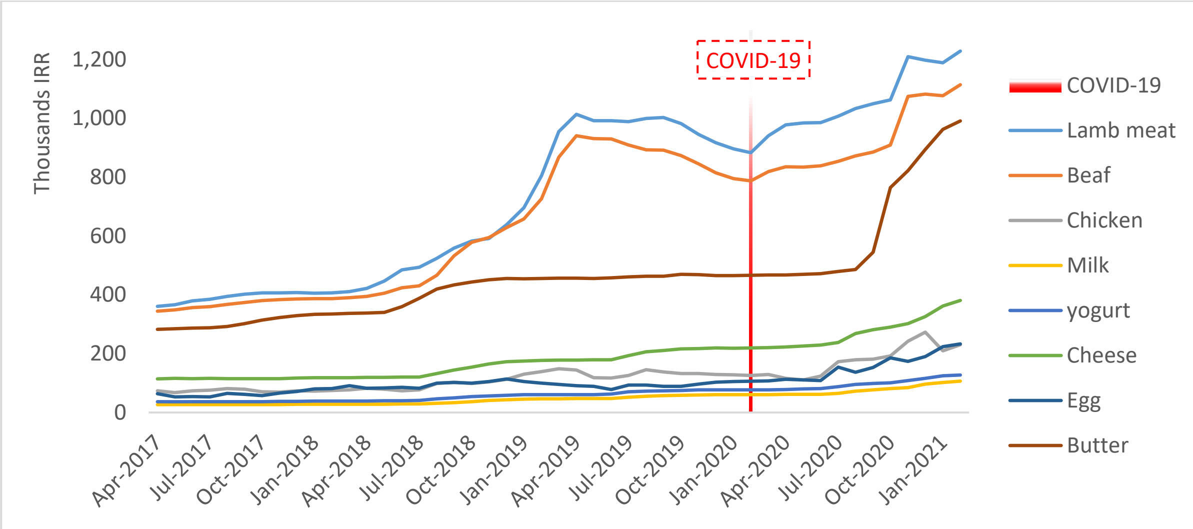

Figure 3. The Average price of selected food items in urban areas of Iran (IRR).
Source: Statistical Center of Iran (2022)

Figure Figure 4 shows that ASF and cereals, bread, flour and noodles account for more than 53% of Iran's basket and both will increase slightly in 2020. Cereals recorded the highest increase, while vegetables and pulses declined, likely due to hygiene issues in the supply chain. The consumption of fruit and nuts increased during the quarantine. Overall, the pandemic has disrupted the Iranian food supply chain, leading to dietary changes and price fluctuations, especially for ASF.

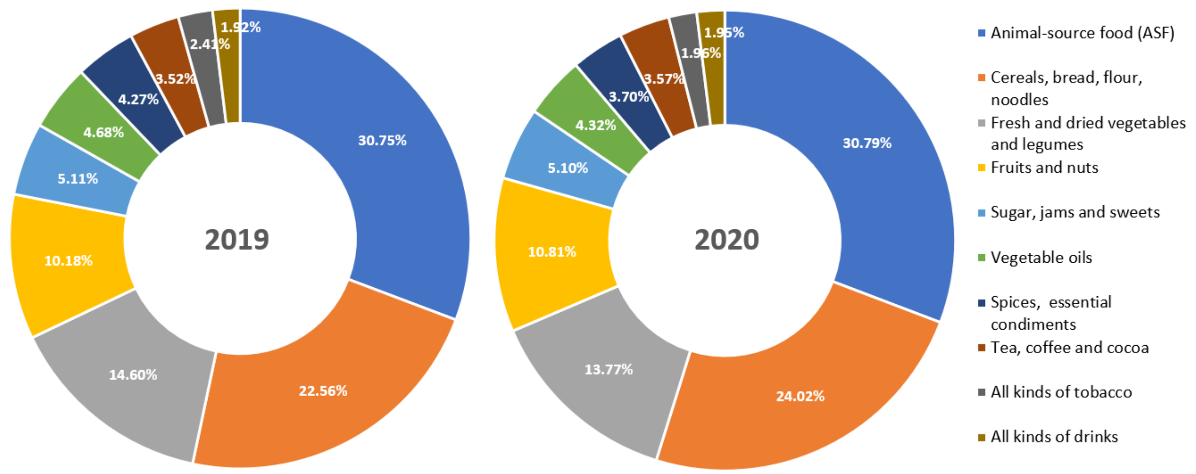

Figure 4. Expenditure share of household food consumption: 2019-20.
Source: Authors

The main objective of this study is to investigate how the COVID-19 pandemic, characterized by a sharp decline in per capita income (Figure Figure 2) and rising food prices (Figure 4), has affected the expenditure share and consumption patterns of ASF in Iranian households. ASF, which include Livestock meat, poultry meat, aquatic meat, dairy products, eggs and fat, are important sources of protein and essential nutrients, and their consumption is often associated with higher nutritional value. The study prioritizes ASFs due to their critical role in providing high-quality protein and essential nutrients that are vital for maintaining health in times of crisis such as the COVID-19 pandemic. Unlike plant-based proteins, ASFs offer complete amino acid profiles and higher bioavailability of micronutrients such as iron, zinc and vitamin B12. However, ASFs are often more expensive and sensitive to supply chain disruptions, making them a focal point for understanding risks to food security. The decision to prioritize ASFs over plant-based alternatives reflects their disproportionate impact on household budgets and adequate nutrition, particularly in middle-income countries such as Iran.

The pandemic has not only reduced household purchasing power but also raised consumer awareness of healthy and immune-boosting diets. This raises the central research question: "How have these economic and health-related shocks affected the distribution of household budgets and the composition of food consumption, particularly in relation to ASF?)". By addressing this question, the study aims to provide a comprehensive understanding of shifts in food demand during a global health crisis, focusing on the interplay between income, prices and food preferences.

The need for this research stems from the urgent need to understand the short- and long-term impact of the pandemic on people's food security and welfare. As households face lower incomes and rising food prices, access to nutritious food, particularly ASF, becomes increasingly difficult. This has significant public health implications, as inadequate protein intake can weaken the immune system (Batlle-Bayer *et al.*, 2020) and exacerbate health vulnerability, especially during a pandemic. Furthermore, understanding how households adjust their food expenditure and consumption patterns in response to economic shocks is crucial for developing effective policies. This study fills a crucial gap in the literature by providing empirical evidence on how COVID-19 has disrupted food demand in Iran, a country with a long-standing history in the upper-middle income (UMI) group, where such disruptions can have far-reaching consequences for both urban and rural populations.

The novelty of this study lies in the application of the Quadratic Almost Ideal Demand System (QUAIDS) model to analyze the short-term impact of COVID-19 on food expenditures and welfare in Iran. Unlike previous studies, that often focus only on income and price elasticity, this study provides a more nuanced understanding of how households prioritize different food categories during a crisis. By distinguishing between rural and urban areas, the study captures regional disparities in food demand and welfare losses, providing insights into the response of different population groups to economic shocks. Furthermore, the study estimates welfare losses through compensating variation (CV) and analyzes the compensated price elasticity (Hicksian), providing a robust framework for assessing the economic impact of the pandemic on household welfare. These results are not only of academic importance but also of practical relevance as they provide policy makers with actionable insights to develop targeted interventions that address nutritional deficits and mitigate welfare losses. At a time of global economic and health disruption, this research contributes to the overarching goal of improving food security and ensuring access to nutrient-rich diets for vulnerable populations.

3 Literature review

The emergence of new coronavirus variants is being observed in many countries, especially in developing countries such as Iran, which are still facing challenges. Due to the limited data available in these countries, there have been few studies analyzing the changes in food demand under pandemic conditions. Most of them have also used the QUAIDS model and found it useful.

Coelho et al. (2010) estimated a QUAIDS for 18 food products using data from a Brazilian Household Budget Survey for the years 2002 and 2003. They showed that purchase probabilities of staple foods were negatively related to family monthly income, while meat, milk, and other products showed a positive relation. They also find that regional, educational, and urbanization variables are also important.

Khoiriyah et al. (2019) analyzed the impact of the price change, income, and household size on the demand for five commodity groups, i.e. eggs, chicken, beef, fish, and powder milk in the Indonesian National Socio-Economic Survey 2016. They used 291,414 data from households in Indonesia which were analyzed by QUAIDS. The result showed that all of the price elasticity was negative and the income elasticity was positive.

Nicola et al. (2020) summarized the socio-economic effects of COVID-19 on individual aspects of the world economy. They showed that the need for commodities and manufactured products has decreased and the food sector is also facing increased demand due to panic-buying and stockpiling of food products.

Poudel et al. (2020) reviewed the possible impacts of the global pandemic COVID-19 on Food and Agriculture across the globe. They pointed the pandemic protocols and provisions interfere with the supply chain of the market with impaired production and distribution accompanied by a lack of labor and supply of inputs. This vastly affects livestock, poultry, fishery as well as dairy production.

Khan et al. (2021) reviewed COVID-19's effects on the agricultural sectors. They showed COVID-19 affects the profit of agriculture, livestock, and fisheries and has opened up inequalities within the food chain. As a result, the epidemic has shown that the food chain is fragile.

Vargas-Lopez et al. (2022) examined how household culinary traditions and food management have changed in Mexico as a result of COVID-19-related restrictions, and their impact on food waste. The results show that the participating households increased their monetary expenditure on groceries and reduced food waste during the pandemic. The estimation of consumer responsiveness to waste, through the introduction of a framework based on QUAIDS, confirmed that, even more during the lockdown, food waste has become a luxury good.

(Kaicker *et al.*, 2022) examined covariates of food security and the impact of COVID-19-induced shocks, among households in India using a nationally representative survey. Using a 2SLS panel regression model, found an important role of incomes, relative food prices, household characteristics, as well as mobility restrictions in response to the rising number of infections in a given region in explaining varying food expenditure shares before and during the COVID-19 pandemic.

The reviewed studies highlight the significant impact of economic and health crises, such as COVID-19, on food demand and consumption patterns across various countries. Coelho et al. (2010) and Khoiriyah et al. (2019) demonstrated the effectiveness of the QUAIDS model in analyzing food demand, showing how income, prices, and household characteristics influence consumption. Nicola et al. (2020) and Poudel et al. (2020) emphasized the pandemic's disruption of food supply chains and increased demand for essential goods. Khan et al. (2021) and Kaicker et al. (2022) further illustrated how COVID-19 exacerbated inequalities in food security and altered household expenditure. Vargas-Lopez et al. (2022) explored changes in food management and waste during the pandemic. Collectively, these studies underscore the need for robust models like QUAIDS to understand and address food demand shifts during crises.

4 Material and methods

The study aims to know how the shock to income per capita in 2020, shown and highlighted in Figure Figure 2, stimulated the sensitivity of households and also determine the price and income elasticity of demand at the household level, as well as the extent of changes in access to ASF and welfare losses. For this purpose, we have used structural econometric models.

4.1 QUAIDS Methodology

Structural econometric modeling, in contrast to non-structural modeling, that lacks economic theoretical foundations, is based on economic theories and takes into account the theoretical relationships between the dependent variable and the explanatory variables. A large proportion of demand models are based on consumer behavior and the maximization of total utility. Several structural models have been presented in the literature. Linear Expenditure System (LES) (Stone, 1954), Rotterdam Model (Barten, 1969), Translog System (Christensen *et al.*, 1973), Indirect Transfer System (ITS) (Christensen *et al.*, 1975), Quadratic Expenditure System (QES) (Pollak & Wales, 1978), Almost Ideal Demand System (AIDS) (Deaton & Muellbauer, 1980), all of which have attempted to provide more flexible systems and adapt theories to experimental studies. More recently, the most popular approach, especially in the food field, has been QUAIDS. Aiming at a more flexible performance and a nonlinear Engel curve coverage more in line with reality, the QUAIDS was introduced by Banks et al. (1997). QUAIDS shows the non-linear responses of price and expenditures changes to demand and provides an estimate of a higher order between consumption of goods and income (Engel curve). The QUAIDS model is derived from an indirect utility function that has the following form Equation ((1):

(1)

$$Ln\, V(P,m) = \left[\left\{\frac{\ln m - \ln a(P)}{b(P)}\right\}^{-1} + \lambda(P)\right]^{-1}$$

Where:

1) $\ln a(P) = \alpha_0 + \sum_{i=1}^{k} \alpha_i \ln p_i + 1/2 \sum_{i=1}^{k} \sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_k$
2) $b(P) = \prod_{i=1}^{k} p_{i=1}^{\beta_i}$

3) $\lambda(P) = \sum_{i=1}^{k} \lambda_i \ln p_i$

The index i stands for the number of goods in the demand system, P is the price of good i, m is the total expenditure, (1) is the translog expansion and (2) is the Cobb-Douglas price aggregator. (3) The household expenditure function is similar to AIDS when $\lambda = 0$. Using Roy's identity in equation ((1), the share equations can be written as follows equation ((2):

$$w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{m}{a(P)}\right) + \frac{\lambda_i}{b(P)}\left[\ln\left(\frac{m}{a(P)}\right)\right]^2 \tag{2}$$

s.t:

1) $\sum_{i=1}^{k} w_i = 1$
2) $\sum_{i=1}^{k} \alpha_i = 1$
3) $\sum_{i=1}^{k} \beta_i = 0$
4) $\sum_{i=1}^{k} \lambda_i = 0$
5) $\sum_{i=1}^{k} \gamma_{ij} = 0$
6) $\gamma_{ij} = \gamma_{ji}$

In order to comply with economic theories and reduce the number of parameters to be estimated, restrictions are applied. The *Restriction (Rst.) 1* to *5* refer to the Adding-up condition. *Rst.5* refers to the homogeneity condition and *Rst.6* refers to the Slutsky symmetry condition. The method introduced by Ray (1983) and further developed by Poi (2002) is used to take demographic characteristics into account. In this method, z is defined as a representative vector of household demographic characteristics. If $e^R(P,u)$ is the expenditure function of the reference household, the expenditure function for each household has the form of $e(p,z,u) = m_0(p,z,u) \times e^R(p,u)$. The function m_0 scales the expenditure function to take into account the household characteristics. Roy decomposes a scalar function in the form $m_0(p,z,u) = \bar{m}_0(z) \times \emptyset(p,z,u)$, where the first term measures the increase in a household's expenditure as a function of z. The second term controls for changes in relative prices and goods actually consumed. Equation ((3) shows the equations for the expenditure shares taking z into account:

$$w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + (\beta_i + \eta_i') \ln\left(\frac{m}{\bar{m}_0(z)a(P)}\right) + \frac{\lambda_i}{b(P)c(P,z)}\left[\ln\left(\frac{m}{\bar{m}_0(z)a(P)}\right)\right]^2 \tag{3}$$

Where:

1) $c(P,z) = \prod_{j=1}^{k} p_j^{\eta_j' z}$
2) $\sum_{j=1}^{k} \eta_{rj} = 0 \ for\ r = 1, \ldots, s.$

η_j' represents the j-th column of the parameter matrix $\eta_{s \times k}$. *Rst.2* should be considered for the Adding-up condition. Different approaches have been used to estimate equation (3). Banks et al. (1997) proposed a two-step GMM method for estimating the system of nonlinear equations to account for the endogeneity and nonlinearity of the regressions. Poi (2008) proposed a nonlinear seemingly unrelated regression (NSUR) method. The NSUR approach was followed in this study. By partially differencing equation (3) in the form $\mu_i = \partial w_i / \partial \ln m$ and $\mu_{ij} = \partial w_i / \partial \ln p_j$, the expenditure elasticity e_i in equation (4) and uncompensated price elasticities (Marshallian) e_{ij}^u in equation (5) are obtained. Using these values and the Slutsky equation, the compensated price elasticity can be estimated (Hicksian) e_{ij}^c using equation ((6). δ_{ij} is Kronecker delta, which is equal to one if $j = 1$ and zero otherwise.

$$e_i = \frac{\mu_i}{w_i} + 1 \tag{4}$$

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij} \tag{5}$$

$$e_{ij}^c = e_{ij}^u + e_i w_j \tag{6}$$

4.2 Welfare change indicator

Understanding changes in welfare requires the use of welfare change indicators such as compensating variation (CV), which have been used in many studies related to the food sector, e.g. in Adekunle et al. (2020) and Mokari-Yamchi et al. (2022). CV is the monetary compensation required to bring the consumer back to the original utility level after the price change (Araar, 2016). The CV can be written as the difference between two values of the cost function (Equation (7); where $\mathrm{e(U, P)}$ is the expenditure function, P is the vector of prices and U is the utility. These changes are measured by the level under the compensated demand curve (Hicksian) following an economic change such as the economic impact of COVID-19.

$$CV = e(U_0, P_1) - e(U_0, P_0) \tag{7}$$

Using a second-order Taylor series and Shephard's lemma for equation ((7), the impact of price changes on the consumer is obtained (Badolo & Traore, 2015):

$$\frac{CV}{x_0} \cong \frac{p_{0,i} q_i(p_0, x_0)}{x_0} \frac{\Delta p}{p_{0,i}} + \frac{1}{2} e_i \frac{p_{0,i} q_i(p_0, x_0)}{x_0} \left(\frac{\Delta p}{p_{0,i}}\right)^2 \tag{8}$$

where q_i and p_i are the quantity demanded and food group price respectively. x_0 is the ASF expenditure and e_i is the Hicks own-price elasticity of demand for a particular food group.

4.3 Data

The data for the estimation of equations 3 to 8 come from the Iran Households Expenditure and Income Survey (IHEIS), which has been conducted annually by the Statistical Center of Iran (SCI) since 1935. The survey, which balances urban and rural households, covers 31 provinces and includes data from 38,099 households in 2019 (before COVID-19) and 37,294 households in 2020 (during COVID-19). The questionnaire comprises four sections: social characteristics of the household, information on place of residence, expenditure on food and other goods and household income. In the food expenditure section, over 630,000 observations were collected for 228 food items, including 58 ASF, which were categorized into six groups: Livestock meat, Poultry meat, Aquatic meat, Dairy products, Eggs, and Oils/Fats (Table 2). Nominal food consumption was calculated on the basis of retail prices, with values recorded monthly.

Table 2. ASF items in the IHEIS questionnaire.

ASF group title	Scope
Livestock meat	The meat of *sheep*, *goat*, and *yeanling*. *Calf* and organ meats
	Other bushmeats, cured meats, sausage, Cold meats
	Meat cans, cured meats, precooked meats including hamburgers, kebab steak, and so on.
Poultry meat	*Hen*, *rooster*, *chicken*, *ostrich*, *turkey*, *goose*, *duck*, *quail*, and *hunting* birds
	Other birds, their offal. and bird meat cans
	Ready to cook meats such as chicken barbecue schnitzel and ...
Aquatic meat	Fresh and frozen fish, smoked and salted fish
	Different fish cans, fresh frozen and cured *shrimp*
	Oysters & *Caviar*
	Other types of ready-to-cook Fish
Dairy products	Kinds of milk, milk powder, and milkshake
	Creams, kinds of ice creams, yogurt, dough, cheese, *pietra cheese*, and kinds of whey
	Kinds of mixed cheese, and *Nagorno qrvt*
Eggs	Local and industrial eggs
	Duck, *goose*, *turkey*, and others
Oil, fat, and butter	Kinds of animal oil, fat, and tallow
	Pasteurized and unpasteurized animal butter

Source: Extracted from the IHEIS questionnaire

Due to the high proportion of informal economic activities, shadow activities (Angrist *et al.*, 2021), and self-employment in developing countries, total household demand was considered as income. Total household demand is calculated from the sum of expenditure on food and beverages, clothing, housing, health, communication and transportation, culture and leisure, education, durable goods and investment based on the data in Part3 of the questionnaire. For a more detailed analysis, the demographic variables of household size and residential status of the household were used as dummies (rural=1/urban=0).

5 Results

Our curiosity was what the response of Iranian households to the arrival of COVID-19 was, as a UMI country that faced the stoppage of the upward trend of GDP per capita growth rate due to the arrival of COVID-19 (Figure Figure 2). The study was conducted with two cross-sectional datasets-2019 and 2020. The results of the analysis include descriptive analysis, estimated elasticities, and welfare losses based on data and parameters. Stata/MP14.0 software was used for statistical analysis.

5.1 Descriptive statistics

The descriptive statistics section provides an overview of the key variables and their distribution in the dataset. This analysis offers insights into household expenditure patterns, particularly for ASF, across urban and rural areas in Iran before and during the COVID-19 pandemic. Table 3 and Figure Figure 5 summarize the mean, standard deviation, and other relevant statistics, highlighting the changes in consumption and expenditure trends over the study period.

Table 3. Summary table of sample characteristics for datasets

Variables	2019 Before COVID-19			2020 Arrival time of COVID-19		
	All	Urban	Rural	All	Urban	Rural
Households	38,099	19,793	18,306	37,294	19,178	18,116
Population ratio (%)		52.0	48.0		51.4	48.6
Household size (Mode)	3.46 (4)	3.43 (4)	3.49 (4)	3.43 (4)	3.40 (4)	3.47 (4)
Age of household head in years	51.5	50.9	52.1	51.8	51.5	52.2
Median age in years	32	32	33	33	32	33
Female-headed household (%)	14	13	15	15	14	15
Ratio of food expenditure (%)	37.87	34.25	41.79	42.08	31.37	53.41
Ratio of Non-Animal food expenditure (%)	69.25	68.47	70.08	69.21	68.39	70.08
Ratio of Animal food expenditure (%)	30.75	31.53	29.92	30.79	31.61	29.92
Expenditure share on livestock meat (%)	20.79	23.01	18.40	21.76	24.08	19.31
Expenditure share on poultry meat (%)	32.27	29.84	34.90	31.84	29.57	34.24
Expenditure share on aquatic meat (%)	5.55	6.16	4.90	5.19	5.71	4.63
Expenditure share on dairy products (%)	29.37	29.67	29.05	27.78	27.93	27.61
Expenditure share on eggs (%)	9.48	8.62	10.41	11.10	10.21	12.05
Expenditure share on oil, fat, and butter (%)	2.53	2.70	2.35	2.34	2.50	2.16
Price of livestock meat (IRR)	667,813	683,496	650,857	820,001 (23%↑)	845,719 (24%↑)	792,775 (22%↑)
Price of poultry meat (IRR)	127,688	128,249	127,080	189,620 (49%↑)	190,864 (49%)	188,304 (48%↑)
Price of aquatic meat (IRR)	417,519	419,092	415,818	582,488 (40%↑)	599,873 (43%↑)	564,084 (36%↑)
Price of dairy products (IRR)	112,630	116,114	108,863	165,240 (47%↑)	171,474 (48%↑)	158,640 (46%↑)
Price of eggs (IRR)	97,069	94,742	99,586	164,749 (70%↑)	161,838 (71%↑)	167,831 (69%↑)
Price of oil, fat, and butter (IRR)	463,726	463,054	464,452	701,863 (51%↑)	703,109 (52%↑)	700,544 (51%↑)

Source: Authors

The demographic characteristics of households remained relatively consistent between 2019 and 2020. The most common household size was four members, and the average age of the household head was 51 years, with a marginal increase of 0.7% in 2020. The median age of the statistical population was 33 years, aligning closely with the global median age of 31.7 years reported by Worlddata.info, which ranks Iran 60th globally. Female-headed households accounted for 14% in 2019, rising slightly to 15% in 2020, reflecting a modest shift in household dynamics.

A significant change was observed in the share of food expenditure, which increased from 37% in 2019 to 42% in 2020. This rise was particularly pronounced in rural areas, where food expenditure surged from 41% to 53%, likely driven by economic pressures exacerbated by the COVID-19 pandemic. In contrast, urban households experienced a 2% decrease in the share of food expenditure. This divergence can be attributed to differing economic vulnerabilities and access to resources between urban and rural populations. The increase in food expenditure aligns with the decline in GDP per capita, as illustrated in Figure Figure 2, which reflects the broader economic contraction during the pandemic.

In 2019, an average of 30.75% of total food expenditure was allocated to ASF, with urban households spending 2% more on ASF than rural households. Despite the overall increase in food expenditure by 5% in 2020, the share of ASF remained stable at 30.7%. This stability occurred despite significant price hikes across ASF categories, ranging from a 22% increase for livestock meat in rural areas to a 71% surge for eggs in urban areas. These price increases are consistent with global trends highlighted by studies such as Akter (2020) and Bai et al. (2022), which noted a widespread rise in food prices following the onset of the pandemic.

The persistence of ASF expenditure share, despite rising prices, suggests that ASF remains a critical component of the Iranian diet, with households prioritizing these foods even under economic strain. This finding underscores the importance of ASF in the food security and dietary patterns of Iranian households, particularly in the context of economic shocks. The data also highlights the resilience of food consumption patterns in the face of price volatility, as households adjusted their budgets to maintain access to essential food groups. Overall, these trends reflect the complex interplay between economic conditions, food prices, and consumption behavior during the COVID-19 pandemic.

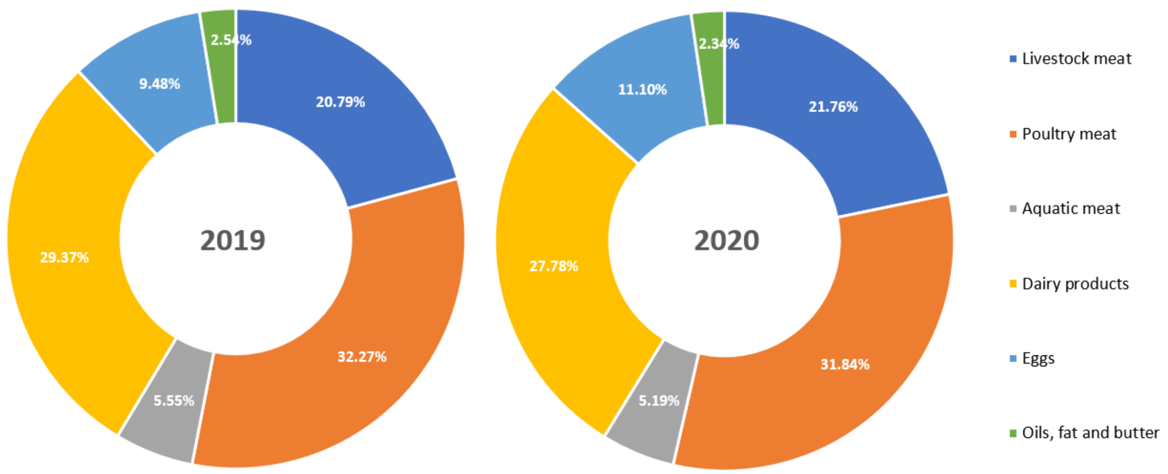

Figure 5. Expenditure share of household ASF consumption: 2019-20.
Source: Authors

Figure Figure 5 graphically shows that the poultry group constitutes the largest share of ASF. The group of eggs increased the most, and the group of dairy products decreased the most. The details show that it was the same in rural and urban areas.

5.2 QUAIDS estimation for the whole sample

The coefficients of the quadratic term (λ_i) in the QUAIDS model were statistically significant for all six food groups (P<0.001), underscoring the superiority of the QUAIDS model over the simpler AIDS model in capturing the nonlinear relationship between expenditure and food demand. Notably, the λ value for the aquatic meat group was closer to zero compared to other groups, suggesting a less pronounced quadratic effect in this category. Tables 4 and 5 present the estimated expenditure elasticities, as well as compensated and uncompensated price elasticities derived from the QUAIDS analysis. Across both years (2019 and 2020), expenditure elasticities were positive for all food groups, indicating the absence of inferior goods. In 2019, the elasticities ranged from 0.33% to 1.90%, while in 2020, they ranged from 0.37% to 1.88%. The groups of livestock, aquatic products, and oils exhibited elasticity values greater than one, classifying them as luxury goods. This implies that consumption of these groups is highly sensitive to income changes, and households are more likely to reduce their consumption of these items during economic downturns.

In Iran, where approximately 71% of cooking oils used in frying are solid vegetable oils (Mohammadi & Salehzadeh, 2019) ,the classification of animal oils as luxury goods aligns with dietary patterns and preferences. Other food groups, such as eggs and poultry meat, displayed positive expenditure elasticities below unity, categorizing them as necessity goods. Eggs, in particular, exhibited the lowest elasticity, reflecting their essential role in Iranian diets. Poultry meat, with an elasticity closer to one, behaved more like a normal good, indicating a more proportional response to income changes compared to other groups. Overall, the QUAIDS model provides a nuanced understanding of food demand in Iran, revealing how income fluctuations differentially impact the consumption of luxury and necessity goods, particularly during periods of economic stress.

The primary diagonal of the matrices presented in Tables 4 and 5 delineates the own-price elasticities, which, as anticipated by theoretical frameworks, exhibit all negative values. The magnitude of these values inversely correlates with the relative significance of each food group among households. Analysis of the data reveals that eggs registered the lowest Hicksian elasticity at -0.34, a figure that remained unchanged in 2020. In 2019, per capita egg consumption in Iran was recorded at 8.33 kg, reflecting a 0.483 percent increase from the previous year. In a global context, Iran is ranked 73rd out of 161 countries regarding per capita egg consumption, as reported by FAO (2022). While aquatic meat is recognized as an excellent source of protein and omega-3 fatty acids, it is perceived as a luxury item within the dietary preferences of Iranian households.

Based on the own-price elasticities, it was found that the demand for aquatic meat and animal oils was particularly sensitive to price fluctuations. The compensated own-price elasticity for oil in 2019, solely indicating the substitution effect, was measured at -1.14, categorizing it as a product with price-elastic demand. In contrast, the groups associated with eggs and poultry meat exhibited a lower sensitivity to price changes. With the exception of aquatic meat (-2.59) and oil (-1.14), the remaining groups were categorized as having own-price inelastic demand, as their elasticity values fell below one when responding to respective price alterations. It is notable that the own-price elasticity for the oil category experienced a substantial increase in 2020, escalating from -1.14 to -1.72.

The principal diagonal of the matrices in Tables 4-3 and 5-3 illustrates the uncompensated own-price elasticities (Marshallian), which account for the income effects of price changes and are generally larger than their compensated counterparts. A comparative analysis of the uncompensated values between 2019 and 2020 highlights an increase for livestock meat, rising from -0.86 to -1. In contrast, the dairy group remained unchanged at -0.89. Additionally, the values denoted as e_{ij} in the matrices of Tables 4 and 5 represent cross-price elasticities. The variation in the signs of certain values indicates that some food items are substitutes for one another, while others complement each other.

Table. 4 Whole sample: Before COVID-19 (2019)

	L. meat	P. meat	A. meat	D. products	E.	O., F., B

4-1: Expenditure elasticity						
	1.90	0.77	1.52	0.68	0.33	1.44
4-2: Hicksian (Compensated)						
L. meat	**-0.47**	0.12	0.019	0.27	0.02	0.02
P. meat	0.08	**-0.63**	0.17	0.25	0.06	0.05
A. meat	0.07	1.01	**-2.59**	0.94	0.33	0.22
D. products	0.19	0.27	0.17	**-0.69**	0.01	0.03
E.	0.05	0.22	0.19	0.03	**-0.34**	-0.16
O., F., B	0.18	0.70	0.49	0.37	-0.61	**-1.14**
4-3: Marshallian (uncompensated)						
L. meat	**-0.86**	-0.49	-0.08	-0.28	-0.15	-0.02
P. meat	-0.07	**-0.87**	0.13	0.02	-0.008	0.036
A. meat	-0.24	0.52	**-2.68**	0.49	0.188	0.18
D. products	0.05	0.05	0.14	**-0.89**	-0.05	0.01
E.	-0.1	0.11	0.17	-0.06	**-0.37**	-0.17
O., F., B	-0.11	0.23	0.41	-0.04	-0.75	**-1.17**

Source: Authors

Table 5. Whole sample: Arrival time of COVID-19 (2020)

	L. meat	P. meat	A. meat	D. products	E.	O., F., B
5-1: Expenditure elasticity						
	1.88	0.76	1.50	0.68	0.37	1.56
5-2: Hicksian (Compensated)						
L. meat	**-0.59**	0.18	0.08	0.28	0.02	0.01
P. meat	0.12	**-0.49**	0.07	0.19	0.05	0.04
A. meat	0.35	0.47	**-2.54**	0.99	0.35	0.35
D. products	0.22	0.22	0.18	**-0.70**	0.02	0.04
E.	0.05	0.14	0.16	0.06	**-0.34**	-0.08
O., F., B	0.12	0.63	0.79	0.55	-0.38	**-1.72**
5-3: Marshallian (uncompensated)						
L. meat	**-1.00**	-0.41	-0.01	-0.23	-0.18	-0.03
P. meat	-0.03	**-0.74**	0.03	-0.02	-0.03	0.02
A. meat	0.02	-0.0007	**-2.61**	0.57	0.18	0.32
D. products	0.07	0.003	0.15	**-0.89**	-0.05	0.03
E.	-0.02	0.02	0.14	-0.04	**-0.38**	-0.09
O., F., B	-0.21	0.13	0.71	0.12	-0.56	**-1.76**

Source: Authors

5.3 QUAIDS estimation for the subsample

Within the span of a single year, the proportion of food expenditure in rural regions rose from 41.79% to 53.41%, whereas in urban regions, this proportion shifted from 34% to 31% (Figure Figure 6). This pattern may be attributed to the phenomenon that, in addition to previous outlays, urban households have allocated part of their income towards preventive and therapeutic health measures. Conversely, rural households, facing diminished income, have concentrated their efforts on sustaining their nutritional intake. The analysis conducted using the QUAIDS model yields moderate evidence countering the significant hypothesis regarding the demographic characteristics associated with residential status (P-Value=0.07). Nevertheless, with a diminished level of confidence, the estimated parameters for both urban and rural settings were scrutinized. Estimates of elasticities for the years 2019-20 are presented in Tables 6 and 7.

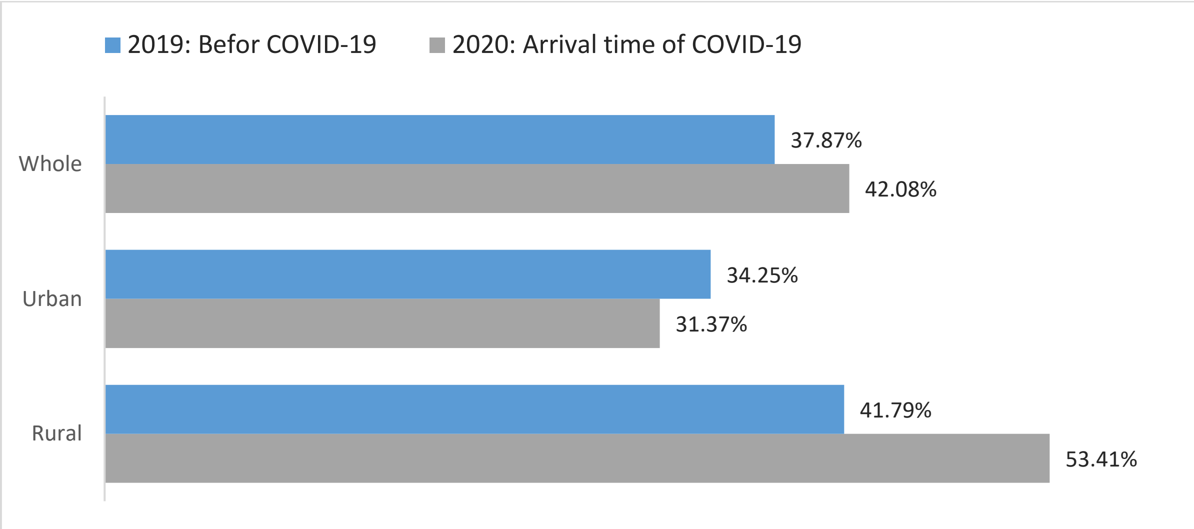

Figure 6. The ratio of food expenditure in Iran. Source: Authors

Table 6. Rural and Urban regions: Before COVID-19 (2019)

	L. meat	P. meat	A. meat	D. products	E.	O., F., B
Expenditure elasticity						
Rural	2.03	0.78	1.60	0.682	0.39	1.48
Urban	1.81	0.75	1.47	0.685	0.27	1.41
Hicksian (Compensated)						
			Rural			
L. meat	**-0.48**	0.16	0.003	0.27	0.02	0.01
P. meat	0.08	**-0.63**	0.16	0.25	0.08	0.05
A. meat	0.015	1.15	**-2.82**	1.03	0.37	0.24
D. products	0.17	0.30	0.17	**-0.69**	0.01	0.03
E.	0.04	0.27	0.17	0.04	**-0.38**	-0.14
O., F., B	0.15	0.75	0.52	0.38	-0.66	**-1.15**
			Urban			
L. meat	**-0.45**	0.09	0.03	0.28	0.02	0.02
P. meat	0.07	**-0.62**	0.18	0.25	0.04	0.06
A. meat	0.12	0.91	**-2.42**	0.87	0.30	0.20
D. products	0.21	0.25	0.18	**-0.69**	0.004	0.03
E.	0.06	0.17	0.21	0.1	**-0.29**	-0.18
O., F., B	0.20	0.66	0.47	0.37	-0.58	**-1.12**

Source: Authors

Table 7. Rural and Urban regions: Arrival time of COVID-19 (2020)

	L. meat	P. meat	A. meat	D. products	E.	O., F., B
Expenditure elasticity						
Rural	1.99	0.78	1.57	0.68	0.41	1.61
Urban	1.79	0.75	1.45	0.68	0.32	1.53
Hicksian (Compensated)						
			Rural			
L. meat	**-0.62**	0.22	0.07	0.28	0.02	0.007
P. meat	0.12	**-0.50**	0.07	0.19	0.06	0.04
A. meat	0.31	0.55	**-2.74**	1.08	0.39	0.39
D. products	0.19	0.24	0.18	**-0.70**	0.03	0.04

E.	0.04	0.17	0.15	0.07	**-0.37**	-0.07
O., F., B	0.07	0.70	0.84	0.57	-0.41	**-1.78**
			Urban			
L. meat	**-0.56**	0.15	0.09	0.28	0.02	0.01
P. meat	0.12	**-0.48**	0.08	0.18	0.03	0.04
A. meat	0.38	0.41	**-2.38**	0.93	0.32	0.33
D. products	0.24	0.19	0.19	**-0.69**	0.01	0.04
E.	0.05	0.11	0.17	0.04	**-0.30**	-0.09
O., F., B	0.17	0.57	0.75	0.54	-0.37	**-1.67**

Source: Authors

The analysis of Tables 6 and 7 reveals significant insights into the consumption behavior of rural and urban households before and during the COVID-19 pandemic. In 2019, rural households exhibited greater sensitivity to income changes compared to their urban counterparts, as evidenced by wide variations in expenditure elasticities across animal source food (ASF) groups, ranging from 0.27 to 2.03. This disparity narrowed in 2020, likely reflecting the economic disruptions caused by the pandemic. Rural households also demonstrated higher sensitivity to price changes, with Hicksian price elasticities for ASF groups showing steeper values in rural areas (e.g., -0.38 for eggs to -2.82 for aquatic meat) compared to urban regions.

A notable observation is the stability of dairy product price elasticity (-0.69) for both rural and urban households during the pandemic, suggesting consistent demand patterns despite the crisis. Conversely, livestock meat and oil groups experienced increased price elasticity in both regions, with rural areas witnessing a more pronounced shift (e.g., oil group elasticity rising from -1.15 to -1.78 in rural areas versus -1.12 to -1.67 in urban areas). This heightened sensitivity underscores rural households' vulnerability to price fluctuations. Meanwhile, poultry and aquatic meat groups showed decreased price elasticity in both regions, indicating reduced responsiveness, possibly due to altered consumption priorities during the pandemic. These findings highlight the differential impacts of economic shocks on rural and urban households, emphasizing the need for targeted policy interventions to address rural vulnerabilities.

5.4 The welfare effects

Welfare effects analysis provides critical insights into how COVID-19 pandemic, influence household welfare and purchasing power. This section examines the welfare implications of price and income changes on rural and urban households, focusing on variations in consumption patterns across ASF groups. The assessment leverages economic models to estimate compensating variation, offering a comprehensive understanding of disparities in welfare losses between regions and ASF categories. The IHEIS contains the required data for equation (8). Table 8 shows per capita consumption values in kilograms per month ($\sum q_i / \sum n_h$) for the households, where q_i and n_h are the quantity consumed and the number of household members respectively.

Table 8. ASF Consumption, 2019-20 (kg per month)

ASF Group	Per capita consumption			World average* (Kg monthly)
	Whole	Urban	Rural	
8-1: Before COVID-19 (2019)				

Livestock meat	0.493	0.433	0.558	2.9
Poultry meat	1.633	1.616	1.651	1.2
Aquatic meat	0.190	0.208	0.171	1.5
Dairy products	3.338	3.172	3.514	1.5
Eggs	0.522	0.528	0.516	2
Oil, fat, and butter	0.055	0.061	0.048	1
8-2: Arrival time of COVID-19 (2020)				
Livestock meat	0.530▲	0.506▲	0.554▼	
Poultry meat	1.539▼	1.559▼	1.518▼	
Aquatic meat	0.179▼	0.201▼	0.156▼	
Dairy products	2.976▼	2.882▼	3.074▼	
Eggs	0.519▼	0.531▲	0.506▼	
Oil, fat, and butter	0.050▼	0.056▼	0.043▼	

* On average from official sources.
The direction of the change (▲▼): The green upward arrow indicates an increase and the red downward arrow indicates a decrease.
Source: Authors

The per capita consumption of most ASF groups declined in 2020 compared to 2019, with the exception of livestock meat and eggs. Urban households notably increased their livestock meat consumption (from 433g to 506g) and slightly raised egg intake (from 528g to 531g). Conversely, dairy products experienced the sharpest decline, with rural consumption dropping from 3.1 to 2.8 kg per person monthly and urban from 3.5 to 3 kg. This reduction highlights shifting dietary patterns, potentially driven by economic constraints or supply chain disruptions during the pandemic. Across the sample, ASF consumption predominantly decreased, except for livestock meat, reflecting uneven impacts on household nutrition and food priorities.

Table 9. CV due to change in ASF group prices, 2019-20

ASF Group	Whole	Urban	Rural
Livestock meat	9.4%	8.6%	10.2%
Poultry meat	13.8%	13.5%	14.2%
Aquatic meat	5.6%	6.6%	4.6%
Dairy products	24.2%	23.7%	24.7%
Eggs	4.7%	4.5%	4.9%
Oil, fat, and butter	2.0%	2.2%	1.8%

Source: Authors

Table 9 highlights welfare losses due to price changes in ASF groups, with losses ranging from 1.8% (oil group in rural areas) to 24.7% (dairy products in rural areas). Rural households generally experienced higher welfare losses, reflecting their greater vulnerability to price fluctuations. However, urban regions incurred greater losses in specific groups such as livestock, aquatic, and oil, potentially due to differing consumption patterns or income constraints. The average welfare loss across all groups was 9.9%, with a standard deviation of 8% and a range of 23%, indicating significant variability in impacts. These disparities underscore the unequal burden of economic shocks on rural and urban populations, emphasizing the need for targeted policies to mitigate adverse welfare effects, particularly in vulnerable rural communities.

6 Conclusion

The research investigates the economic impacts of the COVID-19 pandemic on Iranian households, focusing on ASFs. The study prioritizes ASFs due to their critical role in providing high-quality protein and essential nutrients, which are vital for maintaining health during crises like the COVID-19 pandemic. Unlike plant-based proteins, ASFs offer complete amino acid profiles and higher bioavailability of micronutrients such as iron, zinc, and vitamin B12. However, ASFs are often more expensive and sensitive to supply chain disruptions, making them a focal point for understanding food security risks. The decision to prioritize ASFs over plant-based alternatives reflects their disproportionate impact on household budgets and nutritional adequacy, especially in middle-income countries like Iran. The GDP per capita growth rate, which was on a growing trend for all income groups until 2019, turned negative for all income groups without exception in 2020.

The study addresses critical questions about how income and price shocks during the pandemic influenced household budget allocations and welfare losses. Using cross-sectional data from 2019 and 2020, the authors applied the QUAIDS model to analyze consumption patterns across six ASF groups: livestock meat, poultry meat, aquatic meat, dairy products, eggs, and oils. The findings reveal significant disparities in expenditure elasticities and welfare losses between rural and urban areas, emphasizing the vulnerability of rural households. Notably, the estimated expenditure elasticities for eggs, poultry meat, and dairy products were relatively low (0.33, 0.77, and 0.68, respectively), classifying these items as necessary goods. In contrast, livestock meat, aquatic meat, and animal oils exhibited higher elasticities, indicating their status as luxury goods more sensitive to income shocks. Welfare losses were highest for dairy products (24.2% overall, 24.7% in rural areas), followed by poultry meat (13.8%, particularly in rural regions). Price elasticities exhibited greater sensitivity than expenditure elasticities, indicating that households responded more acutely to price changes than income fluctuations. Rural households demonstrated higher price sensitivity despite lower price increases, underscoring their limited budgetary flexibility. These results highlight the precarious state of food security during crises, particularly for rural populations reliant on ASFs for protein intake.

When comparing these findings with prior studies, they align closely with research conducted in other middle-income countries facing similar economic disruptions. For instance, a study by Liu et al. (2021) examined household dietary adjustments during the pandemic in China and found that rural households were disproportionately affected by price volatility in ASFs, echoing the heightened sensitivity observed in Iran. Similarly, Smith and Dupont (2020) analyzed welfare impacts in Sub-Saharan Africa and reported that rural populations allocated a larger share of their budgets to food during crises, consistent with the Iranian data showing an increase from 47% to 53% in rural food expenditure. Furthermore, the classification of ASFs into necessary and luxury goods based on elasticity estimates is supported by earlier work from Alston et al. (2010), who demonstrated that staple foods like eggs and dairy tend to exhibit lower income elasticities compared to premium proteins such as livestock meat.

7 Policy implications

The results of this study provide important insights for the design of targeted policy measures to improve food security and economic resilience, particularly in the post-COVID-19 period. Although the pandemic has subsided, the long-term economic impacts such as income volatility and rising food prices continue to be felt by households. This research, which estimates food demand for 39,000 households during the pandemic, provides valuable insights for understanding food demand patterns in both urban and rural regions and enables policy makers to pursue effective strategies in similar future crises.

The study highlights the importance of ASF in Iranian diets, which remain a significant component of food expenditure despite price increases. The focus on ASF, rather than plant-based foods, stems from their nutritional value and their sensitivity to income and price changes, making them a critical indicator of household food security. The increase in household expenditure on ASF in 2020 can be attributed to several factors, including supply chain disruptions, inflationary pressures, and reduced purchasing power due to economic contraction. Rural households, in particular, exhibited heightened sensitivity to price changes during the pandemic, driven by their limited access to diversified income sources and higher dependency on local markets.

To address these challenges, it is essential to improve the resilience of the ASF supply chain. This can be achieved by investing in infrastructure, enhancing storage and distribution networks, and providing financial support to producers to mitigate the impact of economic shocks. Additionally, diversifying supply sources and promoting local production can reduce dependency on imports and stabilize prices. Strengthening regulatory frameworks and fostering public-private partnerships can also ensure smoother operations during crises.

Given the differing needs of urban and rural households, the study recommends adopting price-focused support policies for urban areas and social service-oriented policies for rural regions. Urban households, which experienced a decrease in food expenditure share, may benefit from subsidies or price controls on essential food items to alleviate the burden of rising costs. In contrast, rural households, where food expenditure surged significantly, require improved access to social services such as healthcare, education, and financial assistance to enhance their economic resilience. Engel's Law underscores this rationale, as rural households prioritize food spending over other needs, making social services crucial for their welfare.

To positively impact urban households, policies should focus on stabilizing food prices, increasing access to affordable ASF, and providing income support to low-income households. Implementing price stabilization mechanisms, such as government intervention in key markets, can also alleviate affordability concerns. For rural households, interventions should prioritize infrastructure development, capacity-building programs for farmers, and targeted subsidies to reduce the cost of production and consumption. Expanding social safety nets and promoting community-based agricultural initiatives can empower rural populations to sustainably meet their nutritional needs.

Despite the end of the pandemic, the study advocates for exploring plant-based protein substitution to enhance long-term food security. Plant-based proteins are generally more affordable, sustainable, and less vulnerable to supply chain disruptions compared to ASFs. This shift aligns with global trends toward sustainable diets and could reduce dependency on ASFs, particularly in regions where plant proteins are culturally accepted and widely consumed. Such research would inform policies promoting dietary diversification and resilience against future shocks.

In conclusion, the study underscores the need for a multi-faceted approach to food security that considers the unique challenges faced by different communities. By strengthening supply chains, implementing targeted support policies, and addressing the specific needs of urban and rural populations, governments can foster greater economic stability and improve the overall welfare of households in the post-pandemic era. The policy implications derived from this study resonate with existing literature, such as Barrett et al. (2021), who emphasized the importance of targeted interventions for rural areas, and Willett et al. (2019), who advocated for sustainable dietary shifts to enhance long-term food security. Collectively, these findings highlight the relevance and consistency of the current study's recommendations within the broader academic discourse.

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نابرابری‌های روستایی- شهری در تقاضای غذاهای با منبع حیوانی و زیان های رفاهی طی کووید-۱۹ در ایران: رویکرد QUAIDS

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چکیده

همه‌گیری کووید-۱۹ چالش‌های جهانی قابل توجهی ایجاد کرد، از جمله کاهش رشد درآمد سرانه در تمامی گروه‌های درآمدی در سال ۲۰۲۰. بخش پروتئین، به‌ویژه مواد غذایی حیوانی(ASF) ، تحت فشار شدید عرضه و تقاضا قرار گرفت که منجر به نوسانات قیمت شد. این مطالعه بررسی می‌کند که چگونه شوک‌های درآمدی بر نسبت هزینه‌های غذایی و رفتار مصرف ، با تمرکز بر مواد غذایی حیوانی غنی از پروتئین تأثیر گذاشت. با استفاده از مدل QUAIDS، داده‌های بودجه خانوارهای ایرانی، که بر اساس مناطق روستایی و شهری برای سال‌های ۲۰۱۹ (پیش از همه‌گیری) و ۲۰۲۰ (زمان ورود کووید-۱۹) دسته‌بندی شده‌اند، تحلیل و مقایسه شدند. یافته‌ها سه نکته کلیدی را نشان می‌دهند: ۱- سهم هزینه‌های غذایی از ۳۷ درصد به ۴۲ درصد افزایش یافت، با افزایش قابل توجه‌تر در مناطق روستایی. ۲- کشش‌های مثبت هزینه در شش گروه ASF شامل گوشت دام، گوشت طیور، گوشت آبزیان، محصولات لبنی، تخم‌مرغ و روغن‌ها مشاهده شد، درحالی‌که کشش‌های قیمتی خود کالا نسبتاً کمتر بودند. ۳- زیان‌های رفاهی بین ۲ درصد تا ۲۴/۲ درصد در گروه‌های ASF مشاهده شد، که نشان‌دهنده عدم تعادل سیاست‌ها، ناکارآمدی‌های زنجیره تأمین و نابرابری در بهره‌مندی مصرف‌کنندگان است. به‌ویژه، مناطق روستایی زیان‌های رفاهی بیشتری در همه گروه‌های ASF به‌جز روغن‌ها تجربه کردند. این مطالعه پیشنهاد می‌کند که برای مناطق شهری سیاست‌های حمایتی مبتنی بر قیمت و برای مناطق روستایی اقدامات مبتنی بر خدمات اجتماعی اجرا شود تا این نابرابری‌ها کاهش یابند. علاوه‌بر این، برای افزایش اثربخشی سیاست‌ها، تحقیقات آینده باید امکان جایگزینی پروتئین‌های گیاهی را بررسی کنند که می‌تواند یک گزینه پایدار و مقرون‌به‌صرفه برای کاهش تأثیرات اقتصادی و تغذیه‌ای بحران‌های آینده باشد. این یافته‌ها دیدگاه‌های ارزشمندی برای سیاست‌گذاران در جهت بهبود امنیت غذایی و تاب‌آوری اقتصادی در دوران پساکرونا ارائه می‌کنند. برای تکمیل نتایج و دستیابی به سیاست‌های بهتر، مطالعه باید در راستای امکان جایگزینی پروتئین‌های گیاهی توسعه یابد.

واژه‌های کلیدی :کووید-۱۹، غذای با منبع حیوانی، زیان‌های رفاهی، مدل QUAIDS، ایران