

CALORIC INSUFFICIENCY IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT (USING THE EXAMPLE OF ARMENIA)

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Abstract: *Despite sufficient global food production, millions of people still go hungry or are undernourished because safe and nutritious food is not available or, more often, affordable. The relevance of the research is conditioned by the need to identify the causes of malnutrition in the Armenian population and ways to mitigate it.*

The aim of this research is to identify the macroeconomic determinants of calorie insufficiency and assess the impact of socio-economic factors on calorie insufficiency in Armenia during the period 2010–2024. For this purpose, the task was set to study the dynamics of calorie deficiency, identify and assess the main factors influencing it, and based on the research results, present priority measures to reduce calorie deficiency.

The research was conducted using Pearson correlation analysis and OLS (ordinary least squares) regression modeling methods. Regression analysis showed that calorie deficiency in Armenia is caused by a number of factors: income inequality, rising food prices, instability of agricultural production, as well as lack of awareness about a healthy diet. Therefore, its reduction requires a comprehensive policy that will include social, economic, and agricultural measures. This will allow strengthening the food security of the population and support the implementation of sustainable development goals.

Keywords: *food security; calorie insufficiency; poverty; income inequality; sustainable development goal-2.*

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Received: 27/05/2026

Revised: 19/06/2026

Accepted: 19/06/2026

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Introduction

Meeting the food security needs of the population, including during emergencies and martial law, is one of the priorities of the Government of the Republic of Armenia (RA) [1]. In addition to the current geopolitical events, the problem of ensuring food security has become even more acute due to income inequality among the population, fluctuations in food prices, and unequal access to necessary resources. Increasing the level of food security will make it possible to mitigate the consequences of natural, political, security, and other crises, contributing to the socio-economic development of the country. This is also enshrined in the 2nd Sustainable Development Goal (SDG 2) “No Hunger”, and in this regard the RA government has committed to ending hunger, ensuring food security, and improving nutrition by 2030 [2]. The level of food insecurity and food security is influenced by a number of factors: income, gender, education, meal frequency, food structure, dependence on imports, food losses, full and efficient use of agricultural resource potential, etc. Food insecurity in the Republic of Armenia is quite high: more than half of the population is at risk of food insecurity. The latest “Food Security and Vulnerability Assessment of the Republic of Armenia” conducted by WFP records that 23 % of the surveyed households are food insecure, and 56 % are at the threshold of food security [3]. This indicates that the majority of the population of the Republic of Armenia is at risk of becoming food insecure in the event of crisis or shock situations, and the relevance of the topic is conditioned by the need to identify realistic ways to solve it.

The purpose of the research is to identify the causes of caloric deficiency in the Republic of Armenia and to substantiate the priority opportunities for increasing the level of food security and food security. To achieve this goal, the following tasks have been set:

- to present the level of caloric deficiency of the population in the Republic of Armenia in 2010-2023,

- to study the dynamics of the main determinants of caloric deficiency in 2010-2023 / the average monthly income of the population of the Republic of Armenia, the structure of consumer spending on food, food prices, poverty, unemployment, inequality levels,
- to identify the regression correlation between caloric deficiency and the main determinants.
- to assess the impact of each factor,
- to present the possibilities for increasing the level of food security in the Republic of Armenia.

Literature Review

The concept of food security originated in the 1970s and has been constantly evolving since then, reflecting its complexity and the difficulty of implementing it in changing political and operational environments. The concept of food security was first proposed in 1974 at the World Food Summit (WFS) and was defined as “the permanent availability at all times of sufficient supplies of basic foodstuffs to meet the sustainable growth of food consumption and to compensate for fluctuations in production and prices” [4]. According to this definition, food insecurity is caused by a lack of quantitative food resources and high international food prices.

In 1983, the concept of ensuring access to available resources was included in the concept, that is, “paying equal attention to both demand and supply: ensuring that all people have both physical and economic access to essential foodstuffs at all times” [5]. The idea behind this concept was that the determinant of food insecurity was not an inadequate supply of food, but inadequate control over food resources.

In 1996, the concept of food security was included and food security was defined as a situation where people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [6].

Food insecurity, defined as the lack of access to sufficient, safe and nutritious food at all times for an active and healthy life, affects millions of people worldwide [7,8]. Food security is a holistic system that includes the physical availability of food (agricultural production and market conditions), access to food (economic and physical), stability (price and income shocks), and utilization (food security and nutritional knowledge). While people’s ability to access food is determined by personal income and food prices, food security can deteriorate due to falling income levels, high food prices and/or food supply shocks.

Food insecurity is a major challenge worldwide. Given the importance of reducing food insecurity, many researchers have attempted to identify the main determinants of food security and food insecurity, focusing on the dimensions of food safety, availability, and accessibility.

V. Stany found that the causes of food insecurity are multiple: education, gender, income, food quantity, and it is necessary to encourage large-scale production through new technologies, access to food, education and finance, strengthening the capacities of farmer organizations, diversification of activities, access to resources by women, and development of agricultural markets for products and inputs [9].

N. Aziz examining the macroeconomic determinants of food insecurity in South Asian countries, concluded that increased production increases malnutrition and that national food access is not sufficient to reduce malnutrition unless poor people also have economic and physical access to food [10].

S. Lin emphasize the importance of the environment in addition to economic determinants and propose healthy dietary scenarios for Asian countries of different status, taking into account environmental impact, calorie intake, and income level [11].

Olufemi-Phillips consider the increase in food prices as the main determinant of food insecurity and propose to control prices and provide subsidies to low-income households to mitigate its impact [12].

There is almost no research on econometric estimates of the determinants of calorie insecurity in the case of Armenia. The data are mainly focused on food consumption statistics, such as the daily bread consumption of the population in Armenia. From this perspective, the research presented will provide an opportunity to examine the level of calorie insecurity of the RA population and identify its main determinants.

Methodology

When assessing the levels of hunger, poverty, and food security, international organizations (FAO, WHO) use the concept of “minimum dietary energy requirement” and have adopted a threshold of 2100 Kcal/day [13], [14]. In the article, to assess the prevalence of malnutrition, we considered the indicator of caloric deficiency (quantitative energy deficiency) and took as a criterion the proportion of the population consuming less than 2100 Kcal (%).

Table 1

Baseline data on calorie deficiency and factors influencing it in the Republic of Armenia*

Years	The proportion of the population consuming less than 2100 Kcal, (%)	real monthly income, thousand drams	food price index (including alcoholic beverages and tobacco) (%)	Poverty level, (%)	unemployment rate, (%)	Gini coefficient /by income /
	Y	X ₁	X ₂	X ₃	X ₄	X ₅
2010	59.7	94872.5	109.4	35.8	19	0.362
2011	55.5	100364.0	112.3	35.0	18.4	0.371
2012	52.9	110295.0	102.0	32.4	17.3	0.372
2013	59.2	138491.0	105.8	32.0	16.2	0.372
2014	60.2	153961.0	101.7	30.0	17.6	0.373
2015	60.8	165491.8	103.1	29.8	18.5	0.374
2016	62.9	176921.9	96.7	29.4	18.0	0.375
2017	68.9	176056.4	104.0	25.7	17.8	0.359
2018	56.4	168514.1	102.5	23.5	19.0	0.36
2019	76.6	180150.9	102.1	26.4	18.3	0.381
2020	72.6	187466.4	101.2	27.0	18.2	0.363
2021	68.9	190343.3	111.0	26.5	15.5	0.364
2022	75.2	216920.8	112.5	24.8	13.5	0.352
2023	77.4	264700.0	100.4	23.7	12.4	0.348
2024	73.5	286313.1	98.8	21.7	13.3	0.339

*The table was compiled by the authors based on the data of the Food Security and Poverty and Statistical Yearbook of Armenia for 2010-2025.

The study was conducted using Pearson correlation analysis and OLS (ordinary least squares) regression modeling methods. In this case, the level of caloric deficiency was considered as a dependent variable, and the independent variables included real monthly income, share of expenditures on food, poverty, unemployment rates, income inequality index, and Gini coefficient. The primary data were taken from the RA Statistics Committee publications for 2010-2024 (Table 1).

Pearson correlation analysis revealed the presence and degree of correlation between caloric deficiency and the above factors. Correlation coefficients were calculated, which can range from 0 to 1. When developing the theoretical framework of the main regression model, the causal effects of each variable on each other were taken into account. The model allowed us to quantitatively understand which factors had the most significant impact on the level of caloric deficiency. The initial model looks like this:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + \varepsilon_t \quad (1)$$

Where:

Y_t – dependent variable,

X_{it} – independent variables,

β_0 – free term reflecting unobserved heterogeneity,

$\beta_1, \dots, \beta_5$ – independent variables included in the study (it is expected that $\beta_1 > 0$, and the coefficients β_3, β_4 and β_5 will have a negative sign)

ε_t – random error.

Analysis

As 2030 approaches, the challenges to achieving Sustainable Development Goal 2 (SDG 2) to end hunger, improve food security and nutrition, and promote sustainable agriculture remain unaddressed, exacerbated by extreme weather events, the COVID-19 pandemic, soaring food prices, and geopolitical disruptions. These crises have raised hunger and food insecurity levels above pre-2015 levels,

disproportionately affecting low-income populations and threatening other development goals such as poverty reduction and health.

Armenia is not immune to this situation. According to the Statistical Committee, the share of the population consuming less than 2100 Kcal in 2024 was 73.5%, which increased by 13.8 percentage points compared to 2010. In order to identify the causes of caloric deficiency in the Republic of Armenia, a Pearson correlation matrix analysis was performed. It also made it possible to assess the correlation of macroeconomic indicators and identify possible multicollinearity between independent variables (Table 2).

The results of the analysis showed that there are both strong, medium and weak relationships between the variables included in the studied system. The strongest positive relationship is with the real income factor (X_1) ($r=0.802$). This indicates that this factor can be one of the important determinants of the phenomenon under study. A strong, but negative correlation was observed with the poverty rate (X_3) ($r=-0.702$), and the relationship with the unemployment rate (X_4) and the income inequality index (X_5) is relatively weak and insignificant, $r=-0.601$ and $r=-0.478$, respectively. As for the relationship between the consumer price index (X_2) and caloric deficiency, it does not have a significant linear effect: $r=-0.122$.

Table 2

Pearson correlation matrix

	Y	X_1	X_2	X_3	X_4	X_5
Y	1					
X_1	0.8016026	1				
X_2	-0.122489	-0.3811659	1			
X_3	-0.701967	-0.8938357	0.3565606	1		
X_4	-0.601369	-0.7661795	-0.0163309	0.5500551	1	
X_5	-0.478457	-0.7003924	-0.004267	0.6138993	0.7141924	1

The calculation was made based on the data in Table 1.

The correlation between independent variables was also investigated. It was found that: there is a very strong negative relationship between real income (X_1) and poverty (X_3) $r=-0.894$, and the relationship between real income (X_1) and unemployment (X_4) is strong and negative: $r=-0.766$. This indicates a high risk of multicollinearity. There is a strong and positive relationship between unemployment (X_4) and income inequality (X_5) $r=0.714$. There are positive relationships of medium strength between poverty and unemployment, as well as poverty and income inequality, $r=0.55$ and $r=0.614$, respectively.

The results obtained show that caloric deficiency in the Republic of Armenia is caused by several important factors that affect in different directions. If the size of real income acts as a stimulating factor, then the food price index, poverty and unemployment levels exacerbate caloric deficiency.

The results of the multiple linear regression model estimation using the OLS method are presented in Table 3.

The obtained results indicate a close relationship between the phenomena under study ($R=0.865$), with about 75% of the variation in the level of caloric deficiency being due to the variation in the independent variables included in the model.

In the presented analysis, $F=5.34$, F significance $=0.015<0.05$, therefore the model is statistically significant and the combination of independent variables explains the variations in the dependent variable in a statistically significant way.

Now build a regression model based on the data in Table 3

$$Y_t = -156,9356 + 0,0002483X_1 + 0,6858626X_2 + 0,5004911X_3 + 1,1254357X_4 + 20447019X_5 \quad (2)$$

The calculation results show that the real income of the population has the most pronounced effect on caloric deficiency ($\beta=0.0002483$) and with 95% confidence we can claim that when increasing real income by one thousand drams, the proportion of the population consuming less than 2100 kcal will increase by 0.0002483 percentage points. In the case of other factors, although a positive effect is observed, they are not statistically significant, since $p>0.05$.

The summary results of the study are:

1. Rising food prices have a positive impact on calorie insufficiency, exacerbating the problem of food accessibility.
2. Poverty and unemployment levels contribute to increasing calorie insufficiency.
3. Income inequality limits the social outcomes of economic growth.
4. Real income growth alone is not sufficient to address calorie insufficiency.

Table 3*

Results of the multiple linear regression model estimation

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.8647152
R Square	0.7477323
Adjusted R Square	0.6075836
Standard Error	5.2090867
Observations	15

ANOVA						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	5	723.85274	144.77055	5.335278	0.0148933	
Residual	9	244.21126	27.134584			
Total	14	968.064				
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-156.9356	111.80376	-1.4036702	0.1939676	-409.85327	95.982068
X ₁	0.0002483	0.0001011	2.4562532	0.0363816	1.962E-05	0.0004769
X ₂	0.6858626	0.3823701	1.7937138	0.1064441	-0.1791188	1.5508439
X ₃	0.5004911	0.8633451	0.5797116	0.5763311	-1.4525312	2.4535135
X ₄	1.1254357	1.4025795	0.8024042	0.4429909	-2.0474195	4.2982909
X ₅	204.47019	192.79703	1.0605464	0.3165264	-231.66699	640.60737

*The calculation was made based on the data in Table 1.

Conclusion

Caloric deficiency is caused by a number of factors: income inequality, rising food prices, high levels of poverty and unemployment, instability of agricultural production, as well as lack of awareness about healthy eating. Therefore, it is necessary to develop a system of social, economic and agricultural measures to reduce it.

The priority areas for reducing calorie deficiency are:

1. Stabilizing agriculture - for this it is necessary to introduce agricultural technologies that will withstand climate change, ensure effective management of water resources, expand farms and create cooperatives, stimulate local production with subsidies or affordable loans, and reduce dependence on imports.
2. Price stability and control - this will make it possible to increase the physical and economic accessibility of food products. For this, it is necessary to develop measures that will contribute to increasing the supply of food and stabilizing prices. For example, state support programs should encourage agricultural producers to develop logistics systems and storage infrastructure.
3. Increasing the purchasing power of the population – it is necessary to develop measures that will ensure the reduction of poverty levels and income inequality. For example, create jobs in rural communities, expand social programs, create targeted food aid funds for vulnerable groups, periodically review pensions and social benefits in line with changes in food prices, and establish a system of food benefits for poor families

Conflict of Interest

The authors declare no conflicts of interest.

Funding Statement

This research did not receive any financial support.

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