CONSUMERS' FOOD CHOICE AND NUTRITION DISEASES: A MULTIPLE LINEAR REGRESSION ANALYSIS

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Abstract

Nowadays, consumers' confidence in the benefits of food on human health has increased, and health concerns are becoming increasingly significant in food choices. The objective of this research is to identify the types of food that have meaningful associations with health, based on the statistical significance. In pursuing mentioned, a multiple linear regression analysis has been performed, while using statistical data about foods' consumption, and new cases of endocrine, nutritional and metabolic diseases emerged over the last thirty years, in Romania. The main results show that some foods, such as cereals, beef, beer, grapes and melons, have significant statistical associations with new cases of underlined diseases. Research relevance lies in optimizing nutrition and consumers' choices based on healthy eating principles.

Key words: Food consumption, nutrition and metabolic diseases, diet, health.

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Introduction

The linkage between food and health is not newly established, but has been an accepted paradigm for generations (Siddiqui et al., 2022). In recent years,

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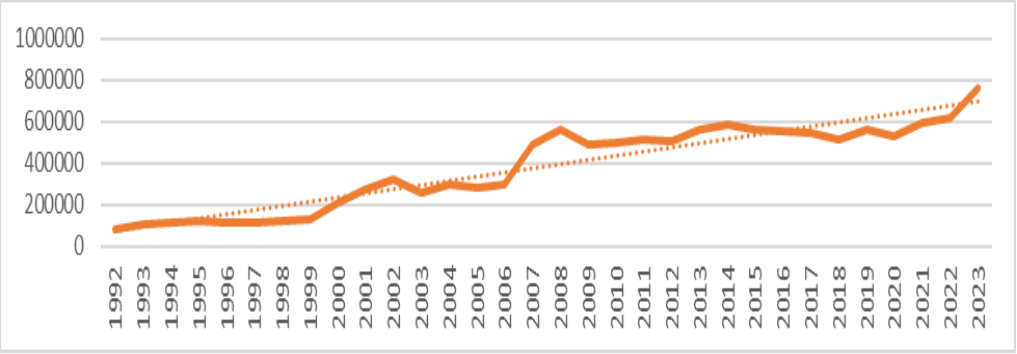
consumers' beliefs in the food benefits upon human health seem to be growing at an unprecedented rate (Ashaolu, Ashaolu, 2020).

The rationale behind this piece of research is that food consumption is very complex, with consumers facing a variety of food choices. One of the factors influencing their choices is health, which plays a significant role in current issues about nutrition. Healthy eating is considered as one of the most important methods of promoting human health, present not only in national political programs and strategies, but also in public discourse (Russell et al., 2020). Nothing less, research shows that consumers are increasingly health-conscious and willing to make health-oriented changes in food consumption (Cammarelle et al., 2025).

One research question arises from this rationale: What are the relationships between consumers' food choices and health (or lack of health, or diseases)? In pursuing this, statistical data indicating food consumption of different types of food and illness expressed as new cases of endocrine, nutritional and metabolic diseases (EDNB) in the last thirty years are computed using multiple linear regression analysis. The objectives of the research are to identify those types of foods that have meaningful associations with health, based on the statistical significance.

Figure 1. Dynamics of the new cases of endocrine, nutrition and metabolic diseases, period 1992-2023, in Romania



Source: Authors' presentation based on NIS, 2025a.

New cases of EDNB is an indicator that measures the number of people registered each year suffering from endocrine, nutritional and metabolic disorders. These are conditions that affect the endocrine (hormonal) system and the processes of nutrient transformation in the human body. This group of diseases includes, among the most common, diabetes, thyroid diseases, obesity, vitamin and mineral deficiencies (Schifter et al., 2021). New cases of EDNB have dramatically increased over the last decades in Romania, as could be seen in Figure 1. (from to

86,000 new cases in 1992 to 762,285 new cases in 2023, or increase for 8.8 times). This significant growth has drawn attention, while required deeper analysis.

Worldwide, the prevalence of metabolic syndrome, including hypertension, malnutrition, insulin resistance, and dyslipidemia, has significantly increased, mostly due to changes in dietary habits, lifestyle drivers, and socio-economic status (Ambroselli et al., 2023). Observational studies have marked possible links between various nutrition patterns and the risk of metabolic syndrome (Agodi et al., 2018). The research results show that healthy dietary pattern is related with lower prevalence of metabolic syndrome, while diet that assume high consumption of red meat and processed meat products, refined grains, alcoholic beverages, and fried food products is linked with high risk of metabolic syndrome.

Food choices influence health. It has been demonstrated that fruits and vegetables' consumption contribute to cardiovascular health, as they contain phytonutrients, potassium and fibers (WHO, 2003), and reduces the metabolic risks (Ambroselli et al., 2023). Whole grain consumption is linked with lower risk of metabolic syndrome, while higher refined grains with higher risk (Kang et al., 2020). Plant seeds (pumpkin, or flax) are becoming increasingly important for treating metabolic syndrome conditions (Akrami et al., 2020; Abdelkader et al., 2022). Total meat consumption (red meat or processed products) positively corresponds to metabolic syndrome, while white meat consumption is inversely linked to them (Kim, Je, 2018).

Based on these results, the hypothesis of this research is that some groups of food, such as fruits and vegetable, or legumes, have negative associations with new cases of endocrine, nutrition and metabolism disorders. Similar was demonstrated in previous studies that fruits and vegetables confer human health benefits (Slavin, Lloyd, 2012; Yahia et al., 2019), while others may have negative effects. One more assumption is made, that consumers make conscious choices based on the knowledge they have about the nutrient content of a food, or about the relation between diet and health. Awareness of the relationship between diet and health is considered the starting point for motivating interest in choosing healthy foods (Zwierczyk et al., 2022). Otherwise, the lack of consumers' knowledge about healthy nutrition could be considered as limitation of performed research.

Although there are numerous studies showing the links between nutrition and health, many of them demonstrating that inadequate diet could rise the risk of chronic illnesses, primarily cancer, and cardiovascular and metabolic diseases (WHO, 2020), few are referring to food consumption and nutritional and metabolic diseases in Romania. Given the demonstrated relationships between diet and

health, it becomes necessary and relevant to explore which foods have significant relations to health, while contributes to it.

The paper has following structure: after the introduction, methodological framework is described, and then the derived results are presented. Further, they are discussed compared to other available scientific results, while finally proper conclusions are drawn.

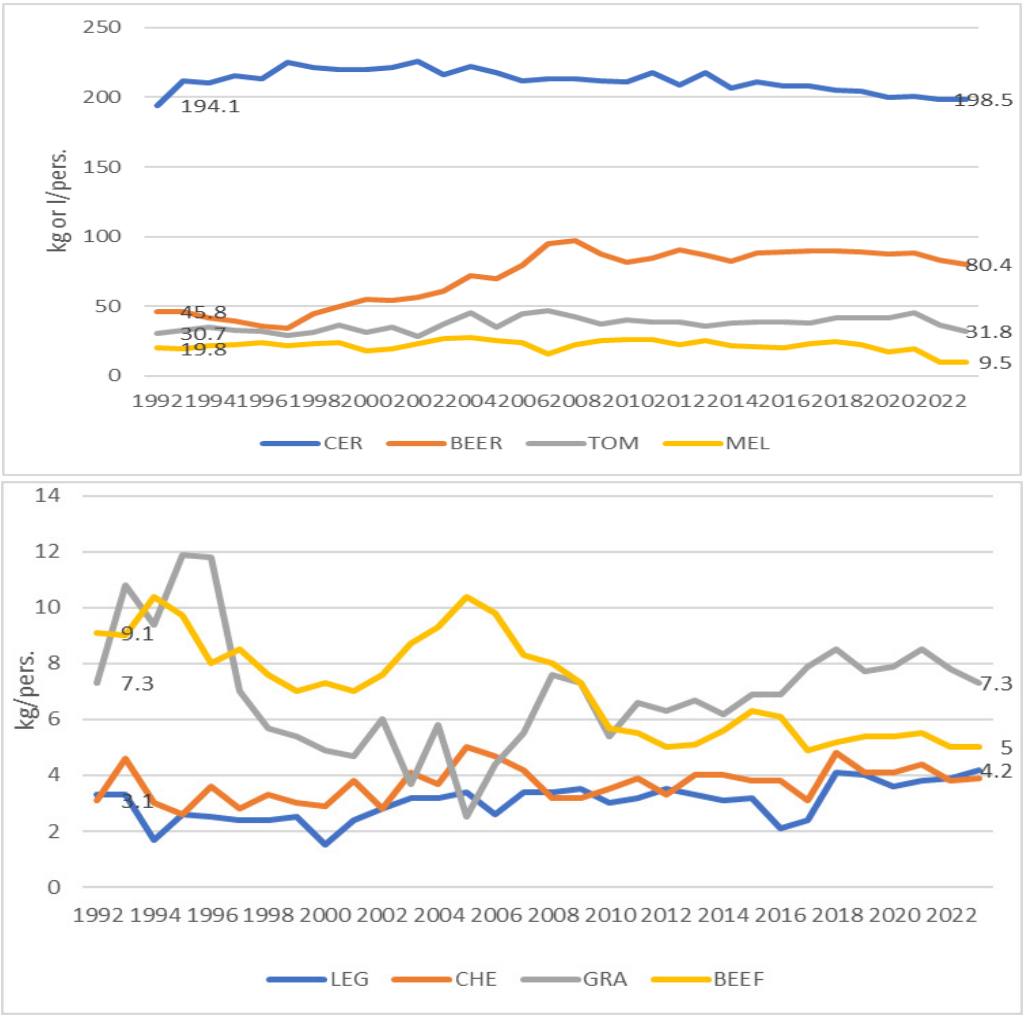
Materials and Methods

The main objective of this study is to identify the potential relationship of the consumption of certain food types with the occurred number of endocrine, nutritional and metabolic diseases (EDNB). For this purpose, the database of the National Institute of Statistics of Romania (NIS) has been accessed. Meanwhile, data about human consumption, as an independent variable, or number of endocrine, nutritional and metabolic diseases, as dependent variable, have been collected.

The dependent variable, new cases of endocrine, nutritional and metabolic diseases (EDNB), expresses the new cases registered each year by family doctors of people suffering from EDNB. Data covers 30 years' period (1992-2023) and they have been briefly presented in introduction.

The independent variable, food consumption, refers to all food categories, while it is expressed in kilograms or liters per person. Used data also covers 30 years' period (1992-2023). The previously selected food categories for analysis have included in total 44 types of foods. These categories covered different types of meat, vegetables, fruits, dairy products, eggs, sugar, cooking oil, as well as non-alcoholic and alcoholic beverages. Initially, in analysis was attempted to use only the total amounts of food groups (meat, vegetables, fruits, etc.), but mentioned have not fit the predefined model due to issues as are collinearity and lack of statistical significance. In order to avoid these problems, while to build a viable model, subcategories of foods have been considered. Therefore, eight independent variables have been selected (as is shown in Figure 2.): beef (BEEF), cereals (CER), beer (BEER), tomatoes (TOM), grape (GRA), melons (MEL), legumes (LEG), and cherries (CHE). Oscillating trends have been observed in consumption of beef, grapes and cherries. Cereals and legumes have a steady trend, while beer consumption has almost doubled, or melons consumption significantly decreased by half. Therefore, two regression models were developed to analyze the relationship between the independent variables and EDNB. Firstly, model (M_0) represents the baseline model with no explanatory power ($R^2 = 0$), while the other model (M_1) includes the selected predictors, achieving a strong fit ($R^2 = 0.970$) and high predictive accuracy (RMSE = 0.059).

Figure 2. Dynamics of consumption of the selected foods in Romania, period 1992-2023 (in kg or l/person)



Source: Authors' presentation based on NIS, 2025b.

Before data procession, they have been log-transformed in Microsoft Excel, and then added to the JASP software, where a multiple linear regression (the main research method applied) has been performed.

Research Results

Observing the model M_1 summary (Table 1.), the value of $R^2 = 0.970$ indicates that 97% out of the EDNB variation is justified by the independent variables, while the results are not coincidental. Adjusted $R^2 = 0.959$ confirms that the established

model works well, even after accounting for the number of predictors included in the analysis. With a Root Mean Square Error (RMSE) of 0.059, the level of predictive accuracy is very high. The Durbin-Watson test equals 1.832, what is quite close to the ideal value of 2. The p value is 0.185, while the autocorrelation value is 0.060. Mentioned three aspects mean that prediction errors are not mutually correlated, while there is no sign of correlation, as well as no connection in the errors.

Table 1. Model Summary

Element					Durbin-Watson		
Model	**R**	**R^2**	**Adjusted R^2**	**RMSE**	**Autocorrelation**	**Statistic**	**p**
M_0	0.000	0.000	0.000	0.293	0.881	0.061	<0.001
M_1	0.985	0.970	0.959	0.059	0.060	1.832	0.185

Source: Authors calculation based on JASP software use.

Table 2. ANOVA data

Model	Element	Sum of Squares	df	Mean Square	F	p
M_1	Regression	2.572	8	0.322	92.002	< 0.001
	Residual	0.080	23	0.003	-	-
	Total	2.652	31	-	-	-

Source: Authors calculation based on JASP software use.

Looking at the ANOVA data (Table 2.), the F-statistic value is 92.002 and the p-value is < 0.001, indicating that the regression model has high statistical significance. Lastly, the main findings are shown in Table 3. The gained results indicate that there are food categories with high statistical relevance, while some don't. Food categories with statistical significance ($p < 0.05$) are:

- Beef meat (logBEEF) with $\beta = -0.586$, and $p < 0.001$. Mentioned values show that beef meat consumption has a negative relationship with the dynamic of the EDNB number, meaning that 1% increase in beef consumption is associated with a 0.586% decrease in EDNB, in case when other factors in model are constant.
- Cereals and cereal based products (logCER) with $\beta = 5.084$, and $p < 0.001$. This category has positive relationship with EDNB, meaning that 1% increase in cereals consumption is associated with a 5.08% increase in the incidence of EDNB, while other factors in model are constant.
- Beer (logBEER) with $\beta = 1.662$, and $p < 0.001$. These values indicate that 1% increase in beer consumption initiates 1.66% increase in EDNB incidences, while other factors in model stay unchanged.

- Melons (logMEL) with $\beta = -0.631$, and $p < 0.001$. Mentioned values show that 1% increase in melons consumption is associated with approximately 0.63% decrease in incidence of EDNB, while other factors remain constant.
- Grapes (logGRA) with $\beta = -0.247$, $p = 0.013$. Gained values show that 1% increase in grapes consumption is linked with approximately 0.24% decrease in EDNB incidences, while other factors are constant.
- Tomatoes (logTOM) with $\beta = 0.770$, $p = 0.008$. This suggests that 1% increase in tomatoes consumption drives to 0.77% increase in the incidence of endocrine, nutritional, and metabolic diseases, while other factors remain constant.

Table 3. Coefficients

Model			Coefficients					Collinea-rity Statis-tics
Model	**Variable**	**Un-standar-dized**	**Standard Error**	**Standar-dized**	**T**	**P**	**Tolerance**	**VIF**
M_0	(Intercept)	5.506	0.052	-	106.485	< .001	-	-
M_1	(Intercept)	-8.896	2.371	-	-3.752	0.001	-	-
	logBEEF	-0.586	0.146	-0.217	-3.997	<.001	0.447	2.235
	logCER	5.084	0.980	0.291	5.185	<.001	0.417	2.395
	logBEER	1.662	0.142	0.811	11.404	<.001	0.261	3.835
	logTOM	0.770	0.266	0.152	2.897	0.008	0.479	2.089
	logGRA	-0.247	0.092	-0.117	-2.684	0.013	0.688	1.452
	logMEL	-0.631	0.125	-0.231	-5.038	<.001	0.629	1.590
	logLEG	0.079	0.139	0.028	-0.567	0.576	0.525	1.903
	logCHE	-0.140	0.198	-0.036	-0.0	0.487	0.519	1.929

Source: Authors calculation based on JASP software use.

The product categories legumes (logLEG) and cherries (logCHE) are not statistically significant according to the regression model because they have a p-value that is too high.

Discussion

The results show that some foods' consumption, like beef, cereals, beer, grapes and melons are significantly associated with the number of new cases of endocrine, nutrition and metabolic diseases (EDNB). This does not mean that other food types are not linked to the number of new EDNB cases, but only that the dynamics of consumption and choices that consumers have made in recent three decades do not place them in a statistically significant relation.

As regards beef consumption, it has a negative relationship with new cases of EDNB. These results correspond to those found in scientific literature. Pighin and associates

(2016) consider beef as part of balanced diet that enhance nutrition security, especially in developing regions. Thomas and associates (2014) have underlined the important role of animal farming, both in terms of producing high-quality proteins, or for providing rural livelihoods and contributing to overall food security.

Moreover, in diets where beef is absent or used in small quantities, the preponderance of food that inhibit the absorption of ferric acid has been noted (Pighin et al., 2016). Considering the fact that the absorption of micronutrients by the human body is strongly affected by combination of foods consumed in a particular meal (Tontisirin et al., 2002), the presence of beef, with its specific fat content, contributes to the absorption of provitamin A, carotenoids, vitamin A, and other fat-soluble vitamins (D, E, F).

Other researchers (Godfray et al., 2018) have found that meat consumption in general could pose certain risks to health. There are some reports warning against its harmful metabolic effects, particularly those related to cholesterol and saturated fatty acids accumulation. Still, among the types of meat, beef is considered healthier in terms of micronutrient content. Iron, selenium, zinc, and potassium content in beef is being higher than in pork and white meat, such as chicken (Pereira, Vicente, 2013).

The other type of foods with significant influence on EDNB are cereals, as they have resulted in a positive relationship. These results are in line with those obtained by You and Henneberg (2016), who are arguing that wheat availability is independent predictor of the obesity prevalence. Consumption of cereals affects both, obesity and diabetes. Thus, Tang and associates (2024) have stated that cereals consumption and diabetes are related, explaining that reducing the portions of staple foods such as grains, while increasing the portions of mixed fruits, eating the whole grains, and consuming the fruits with a low glycemic index can help in reducing the severity of hyperglycemia.

But, cereals represent a nutritive source of food that is easily accessible, while ensuring food security in many states worldwide. In low- and medium-income countries, the core of human diet is focused to cereal-based food products, while the lack of cereals leads to hunger and undernourishment, as is declared by Poutanen (2012). Cereals are highly caloric, and possess high volumes of fiber, B vitamin, zinc, and iron. All mentioned are aspects that largely contribute the prevention of cardiovascular diseases, diabetes, etc. Moreover, cereals are relatively cheap, generally affordable and available everywhere (Aune et al., 2016).

Beer has resulted to have statistically significant positive influence on new cases of EDNB. De Gaetano and associates (2016) have found that large consumption

of alcoholic beverages (specifically beer) exerts deleterious effects on the human body, increasing the health risks for certain human organs (mainly liver). Bendsen and associates (2013) have showed that beer intake over 500 ml/day may positively correspond to abdominal obesity. So, significant increase in beer consumption, from 45.8 liter/person in 1992 to 80.4 liter/person in 2023, in Romania, may be considered as one of the factors that affect the increase in number of new EDNB cases.

It has been also found that melons and grapes have a negative association with the dynamics of the number of EDNB. In previous period has been already demonstrated that increased fruit and vegetable consumption is linked to lower incidences in obesity (Slavin, Lloyd, 2012), while their essential nutrients and phytochemicals, both are contributing to health. Smith Warner and associates (2001) have noted that larger intake of green leafy vegetables corresponds to 14% reduction in risk of type II diabetes.

One particular observation should be pointed out. Although overall fruit and vegetable consumption contributes to a reduced risk of several diseases, the relationships are much less impressive when a particular food product or specific component is correlated (Ashaolu, Ashaolu, 2020), like in the case of present research showing that, of all fruits initially considered for analysis, watermelon, tomatoes and grapes consumption has statistically significant impact on EDNB. Melons and grapes consumption are linked to decreases in number of EDNB, while tomatoes consumption leads to their increase. This is considered as a research limitation.

The gained results have also proved that knowledge of healthy eating principles, such as consuming more vegetables, fruits, nuts, and fibers (Graur et al., 2006), is not enough, suggesting that there are other factors influencing food choices, mainly economic factors, as are prices and level of income, or some social and psychological factors, etc. It has been also observed that, despite high levels of knowledge, fiber intake is so low, while fat intake is so high, suggesting that factors which intervene in food choices, such as convenience, taste, and dining out, have a significant influence (Zwierczyk et al., 2022).

Conclusions

The performed study has explored possible relationships between food consumption and certain diseases, expressed in new EDNB cases registered by family doctors, within the period 1992-2023, in Romania. The gained results showed that, among all foods, significant associations have been recorded in the case of cereals, beef, beer,

grapes, and melons. Among these statistically significant relations, positive effects on health have been found in the case of beef meat, melons and grapes, partially confirming the hypothesis assumed at the beginning of the research arguing that some groups of food, such as fruits and vegetable, or legumes, have negative associations with new cases of endocrine, nutrition and metabolism disorders (EDNB).

An intrinsic conclusion of this study is that, in the last three decades, the food choices of Romanian consumers significantly influence health only in the case of small group of foods, meaning that there are many other factors contributing the overall health of population. This demonstrates either a lack of consumers' knowledge about healthy eating, or a lack of motivation.

Moreover, performed study did not aim to classify foods as good and bad for health. Closer goal was to optimize nutrition, for which consumers may change their diets considering both their preferences or beliefs, and results of scientific studies.

Performed research has some limitations. The derived results are appropriate for food consumption and endocrine, nutritional and metabolic diseases (EDNB) in Romania for particular period of the last thirty years, while cannot be extrapolated and valid in other circumstances. Moreover, the study has examined the links between diet and health using a multiple linear regression analysis, therefore, the theme is approached from mathematical perspective, rather than from traditionally biological or chemical aspects. Instead of focusing on these specific effects of individual foods, performed research uses statistical models to analyze how different food consumption patterns (different food products) relate to new cases of EDNB at national level. Future research should explore the appropriate assessment of real effects of foods and their components on health, by identifying sensitive and reliable biomarkers.

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