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## RESEARCH ARTICLE

### Impact of nutrition on the risk of developing non-communicable diseases – A study of 912 individuals from Laconia, Greece.

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#### Abstract

**Background:** Diet and nutrition play an important role in maintaining health and preventing disease. Poor diet or overeating have been suggested as risk factors for developing certain chronic non-communicable diseases such as cardiovascular diseases, diabetes type II, and cancer.

**Objectives:** Investigate the association between types of nutrients and the risk for development of nutrition-related non-communicable diseases (NCDs) in the residents (35-65 years) of the Municipality of Laconia, Greece.

**Methods:** A random sample of 912 individuals was selected from the population. A quantitative questionnaire was employed for the collection of: demographic characteristics, food consumption frequency, and NCD risk-levels in 16 systems of the organism. T-test and ANOVA was carried out to determine differences between individuals based on demographic characteristics and multiple regression analysis to determine association between different nutrient types and risk for development of nutrition-related NCDs.

**Results:** There are significant differences in nutrient consumption between individuals with respect to the demographic characteristics studied. The findings show a strong correlation between diet and the risk of developing problems/ diseases in all body systems. Fish/seafood, fruits, vegetables and milk/dairy products reduce the risk, while eggs, sweets, cooked traditional dishes of the Greek cuisine and fast food increase it. Cereals, legumes, potatoes, meat and alcoholic drinks show mixed results.

**Conclusion:** Health care professionals should strongly recommend individuals to adopt a diet that is based on the regular consumption of fish/seafood, fruits, vegetables and dairy products, and to avoid the consumption of eggs, sweets, fast-food and traditional dishes of the Greek cuisine, in order to lower the risk for developing NCDs like obesity, diabetes type II, cardiovascular diseases and some types of cancer. As the population of Laconia is experiencing serious health problems, the return to the traditional Mediterranean diet should be a key objective.

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#### Background

It is well known and documented that diet and nutrition, physical activity levels and lifestyle play an important role in maintaining health and preventing disease [1-2]. Weatherby [3] lists the following principles on which good health is based: proper nutrition; enough sleep; proper stress management; good digestion; absorption and assimilation of nutrients; proper defecation; optimal levels of salts and micro-elements; balanced levels of essential lipids; good regulation of the metabolism of sugars; proper hydration; adequate levels of vitamins; balanced levels

of hormones such as epinephrine, thyroxin, oestrogens and androgens; good cardiovascular function; and proper functioning of the kidneys, bladder and the immune system.

The vast changes that have taken place around the globe over the second half of the twentieth century, have caused major changes in the diet of populations, first in the developed countries and more recently in developing countries. Traditional dietary habits that relied mainly on vegetables and fruit were replaced by diets high in fat and energy, and with significant content in foods of animal origin. The importance of nutrition for prevention and management of chronic non-communicable diseases is known [4]. Chronic non-communicable diseases include: cardiovascular diseases, stroke cancer, problems of metabolism and the endocrine system, gastrointestinal diseases, kidney failure, psychiatric problems and diseases of the central nervous system, diseases of muscles and bones, respiratory problems, reproductive dysfunctions, and, dermatological diseases [4]. Nutrition-related chronic non-communicable diseases are caused directly or indirectly by the shortage of essential nutrients in the diet. They are usually diseases associated with chronic malnutrition although in recent decades in the Western world they are associated with obesity from overeating and binge eating, which may also cause, or contribute to the development of serious health problems [5]. Most chronic non-communicable diseases are usually preventable with lifestyle change [6].

Poor diet or overeating have been suggested as risk factors responsible for 2/3 of the risks for developing certain chronic non-communicable diseases such as diabetes type II, cardiovascular diseases and a significant proportion of other chronic diseases such as cancer [7]. Health problems are related to specific nutrients [8] and overall eating habits [9], while disease factors are generally associated with foods or dietary habits, with or without the presence of obesity [10]. Excessive energy intake, particularly through the consumption of energy dense foods that have low levels of nutrients, is a major problem of industrialised societies. Moreover, even excessive consumption of healthy foods can increase the postprandial (and potentially chronic) metaflammation [11], suggesting negative long-term effects. At the other extreme, energy intake restriction is now well documented to be associated with increased longevity and better health [12].

In relation to the quality of the diet, studies have reported an increased risk and increased levels of malfunctions from the consumption of excessive amounts of sugar, salt, alcohol, and saturated and trans fatty acids, as well as insufficient levels of fibre, fruits, vegetables, cereals and certain nutrients (e.g., vitamins and micro-elements) [4,10]. Processing levels have been proposed as a general indication of risk [13], and there seems to be a clear postprandial dysfunction from processed foods versus raw foods [4,13-14]. Although personal and genetic factors affect the results [15], the worst case scenario for obesity and chronic disease, based on the existing evidence, is a modern Western diet consisting of increased consumption of processed foods [9-10].

It is important to note that chronic non-communicable diseases are the main causes of death in Europe. According to the World Health Organisation [17] coronary heart disease and other cardiovascular diseases account for 37% of deaths worldwide, various types of cancer (e.g., breast, large intestines, stomach, etc.) for 22%, stroke for 17%, and respiratory problems for 6% of deaths worldwide. Beyond the medical care that individuals that already suffer require, primary care that aims to prevent nutrition-related diseases should become the major objective of healthcare systems, because it is the most effective, economical and long-term sustainable way to tackle this epidemic globally [17].

In modern Greece, the changes in eating habits and physical activity levels made gradually over recent decades and the moving away from the Mediterranean diet changed the disease spectrum of the Greek population to nutrition-related diseases and anomalies [18]. In terms of life expectancy, Greece is in a relatively good position in the world rankings. According to the statistics presented by WHO [17], Greece has an average life expectancy at birth of 79.5 years (76 for men and 82 for women). Greece ranks in 21<sup>st</sup> position globally and 11<sup>th</sup> in the European Union. The main causes of death in the Greek population in 2009, in descending order were: cardiovascular diseases, malignant neoplasms and cancer, the diseases of the respiratory system and external causes that are responsible for injuries and poisonings. In this respect, 43.3% of deaths in Greece were due to diseases of the circulatory system, while the malignant neoplasms and cancer accounted for 25.2% of deaths, respiratory diseases were responsible for 6.2%, with the remaining reasons to follow with much smaller percentages of the population [18]. Thus, there is an urgent need for the recording, study, evaluation and monitoring of the dietary habits, physical activity levels and lifestyle of individual populations throughout Greece, as is done in other countries around the world. In this respect, the purpose of the current study is to explore relationships between the frequency of consumption of different types of nutrients

by the residents of the Municipality of Laconia that are middle-aged (35-65) and the dangers and risks of developing nutrition-related non-communicable diseases.

Today, health systems and research centres spend the bulk of their resources to find ways for the treatment of illnesses. The great challenge for developed and developing countries, is to reverse this situation, and shift from a defensive policy of combating the disease to more proactive approach of health promotion. The study of factors affecting the eating habits of a population helps to better understand the behaviour of its members and allows researchers, scientists, society and the State to develop more effective interventions that are tailored to the circumstances and to improve lifestyle, physical fitness and life expectancy of residents [19].

The survey provides information to researchers and the academic community, the medical and nursing staff, nutritionists, fitness instructors, local communities and regulators, in order to develop programmes to improve eating habits of the population of the Municipality Laconia, but also other regions in Greece. Similar surveys are rare in Greece and the health problems faced by the Greek population, particularly with the gradual moving away from the Mediterranean diet, urgently needs study that will demonstrate the points on which all stakeholders need to focus, especially the State and the scientific community. Disease prevention helps a population to improve levels of health and quality of life of its members and at the same time prevents the development of diseases that burden the Healthcare System and the State's budget.

## **Materials and Methods:-**

### **Study design:-**

The research follows the quantitative research paradigm and the primary information was gathered with the help of a questionnaire with three parts. The objective was to find associations between various types of nutrients and the risk for developing nutrition-related non-communicable diseases in 16 systems of the human organism.

### **Sample:-**

Purposive sampling was employed at the beginning of the process, which employed three selection criteria: all participants had to be residents of the Municipality of Laconia; Greek citizens; and, in the 35 to 65 years age range. However, subsequently random sampling was applied, as each individual with these characteristics had the same probability of selection in the sample. The 35-65 age range was selected because these individuals are more prone to nutrition-related non-communicable diseases. Individuals above the age of 65 were excluded from the study because the development of co-morbidity at older ages can create problems of reliability and validity in small samples. Individuals below the age of 35 years were excluded from the study because they show smaller frequencies of nutrition-related non-communicable diseases, which in small samples may go undetected.

In order to ensure the validity and reliability of the results the study employs a large sample size that corresponds to almost 2% of the permanent residents of the Municipality of Laconia that were middle aged (35-65), according to the latest census of the Greek population in 2011. A total of 1,020 questionnaires were distributed to the residents of the Municipality of Laconia, but only 912 (89.41%) were returned to the researcher. The levels of non-response for various reasons amounted to 10.59%.

### **Measurements:-**

All primary information was collected using a questionnaire that had three parts: (a) demographic characteristics (e.g., age, height, weight, family status, education level, vocation, and residential zone); (b) Food Frequency Questionnaire (FFQ) for assessing the frequency of consumption of different types of nutrients; and, (c) the Nutritional Assessment Questionnaire for the determination of non-communicable disease risk-levels in 16 systems of the organism.

The primary data for the frequency of consumption of the various types of foods was done using a FFQ. Several studies have employed such questionnaires for the assessment and evaluation of the frequency with which particular foods or groups of foods are consumed by individuals during a given period [21-23]. In a recent survey conducted in Greece [24] the validity and reproducibility of its Greek version was tested with positive outcomes. So its use is ideal for the study of the eating patterns of the population around Greece. The questionnaire that was used had 100 questions.

The Nutritional Assessment Questionnaire was developed by Weatherby [4] and has been used widely by the medical community for the assessment of risk associated with different systems of the human organism. This part of the questionnaire had a total of 270 questions. The scoring was determined based on the assessment instructions provided by Weatherby [4].

#### **Study Approval:-**

The study was approved by the Bioethics Committee of the University of Peloponnese. Written informed consent was obtained from all individuals that agreed to participate in the study. For confidentiality purposes no personal details of the participants were recorded.

#### **Statistical analysis:-**

Continuous variables are presented as mean and standard deviation with maximum and minimum range, while categorical variables are presented as relative frequencies. Histograms and P-P plots were applied to evaluate the normality of the distribution of the continuous variables. BMI categories were calculated according to the proposed cut-off points suggested by International Obesity Task Force (IOTF). Correlations between continuous variables were examined with the Pearson's product-moment correlation coefficient, after checking for the assumptions (e.g., linear relationship between the correlated variables, independency, homoscedacity and normality) with the use of scatter plots.

T-test and ANOVA was employed to assess the differences in the consumption frequency of different types of nutrients between the various groups based on the demographic characteristics.

Multivariate linear regression analysis with the risk for non-communicable diseases in a particular system as the dependent outcome was carried out with the following determinants (independent variables): sex, age, BMI and sixteen entries for the different types of nutrients identified. In total, 16 multivariate linear regression analyses were performed that corresponded to the risk associated with the 16 different systems of the human organism studied. Normality of the residuals derived from the linear regression was tested using Kolmogorov-test and P-P plots, homoscedacity was evaluated by fitting scatterplots of standardised residuals against predicted values, the Variance Inflation Factor (VIF) was calculated to test for colinearity of the independent variables and the Durbin-Watson criterion was applied to evaluate serial dependency of BMI. Hosmer and Lemeshow's goodness of fit test was calculated in order to evaluate the model's goodness-of-fit and residual analysis was implicated using the dbeta, the leverage, and Cook's distance D statistics in order to identify outliers and influential observations.

All analyses were performed using the SPSS 18.0. Statistical significance level from two-sided hypotheses was accepted at the 5% level ( $p \leq 0.05$ ).

#### **Results:-**

##### **Baseline characteristics of individuals:-**

The demographic characteristics of the participants are presented in **Table 1**. From the 912 participants in the research 448 (49.1%) were men and 464 (50.9%) were women. The mean age of the participants was  $49.71 \pm 9.27$  years (35, 65), the mean weight was  $79.02 \pm 16.43$  kg (30, 151), the mean height was  $171.48 \pm 9.00$  cm (150, 199), and the mean BMI was  $26.75 \pm 4.53$  kg/m<sup>2</sup> (11, 47). The mean age of men was  $52.19 \pm 9.93$  years (35, 65) and of women was  $47.31 \pm 7.90$  (35, 65), the mean weight of men was  $87.58 \pm 13.50$  kg (60, 141) the mean weight of women was  $70.75 \pm 14.70$  kg (30, 151), the mean height of men was  $177.56 \pm 7.54$  cm (155, 199) and of women was  $165.60 \pm 5.83$  cm (150, 181), and mean BMI of men was  $27.78 \pm 3.73$  kg/m<sup>2</sup> (21, 41) and of women was  $25.78 \pm 5.02$  kg/m<sup>2</sup> (11, 47).

As far age groups are concerned 303 participants were 35-44 years (33.2%), 302 were 45-54 years (33.1%), and 307 were 55-65 years (33.7%). As far as marital status is concerned the majority of the participants 714 (78.3%) were married/partnered, while the rest 198 (21.7%) were single/divorced. As far as residential zone is concerned the participants in their majority lived in urban areas 416 (45.6%), while 332 (36.4%) lived in rural and 164 (18.0%) lived in semi-urban areas. As far as education level is concerned 518 (56.8%) of the participants had attained a maximum of high school education, while 322 (35.3%) had undergraduate, and 72 (7.9%) had postgraduate qualifications. With respect to their employment is concerned 286 (31.4%) were self-employed, 188(20.6%) were famers, 140 (15.4%) were civil servants, 140 (15.4%) were employees of the private sector, 158 (17.2%) had other form of employments, and 168 (18.4%) were unemployed. As far as BMI category is concerned, the majority, 373

(40.9%) were of normal weight, (20-25), 343 (37.6%) were overweight, 178 (19.5%) were obese (31-40), 12 (1.3%) were severely obese (>40). Only 2 out of 5 had normal weight.

**Table 1 – Demographic Characteristics:-**

Continuous Variables		Mean ± SD
Age (years)		49.71 ± 9.27
Height (cm)		171.48 ± 9.00
Weight (kg)		79.02 ± 16.43
BMI (kg/m <sup>2</sup> )		26.75 ± 4.53
Age	Men	52.19 ± 9.93
	Women	47.31 ± 7.90
Height (cm)	Men	177.56 ± 7.54
	Women	165.60 ± 5.83
Weight (kg)	Men	87.58 ± 13.50
	Women	70.75 ± 14.70
BMI (kg/m <sup>2</sup> )	Men	27.78 ± 3.73
	Women	25.78 ± 5.02
Categorical Variables		(%)
Sex	Men	49.1%
	Women	50.9%
Age Group	35-44	33.2%
	45-54	33.1%
	55-65	33.7%
Marital Status	Single/Divorced	21.7%
	Married/Partnered	78.3%
Residential Zone	Urban	45.6%
	Semi-Urban	18.0%
	Rural	36.4%
Educational Level	≤12	56.8%
	Undergraduate	35.3%
	Postgraduate	7.9%
Vocation	Farmer	20.6%
	Self-Employed	31.4%
	Civil Servant	15.4%
	Private Sector Employee	15.4%
	Other	17.3%
	Unemployed	18.4%
BMI Category	Underweight (<20)	0.7%
	Normal (20-25)	40.91%
	Overweight (26-30)	37.6%
	Obese (31-40)	19.5%
	Strongly Obese (>40)	1.3%

The frequencies of consumption of different types of nutrients are presented in **Table 2**. Of the 912 participants the majority, consume often or every day the following types of food: 848 (93.0%) consume olive oil, 784 (86.0%) consume fruits, 754 (83.9%) consume bread and cereals, 715 (77.5%) consume milk and dairy products (e.g., cheese, yoghurt, etc.), 713 (78.1%) consume coffee and tea, 690 (75.6%) consume vegetables, and 486 (53.4%) consume sweets. In their majority the participants state that they consume 1-2 times per week the following types of food: 610 (66.9%) consume legumes, 601 (65.9%) consume meat and meat products, 510 (55.9%) consume traditionally cooked dishes of the Greek cuisine (e.g., moussaka, pastitsio, etc.), 491 (53.8%) consume potatoes, 379 (41.5%) consume soft drinks, 521 (35.0%) consume fast food or junk food and 377 (41.3%) consume eggs. In their majority the participants state that they consume 1-2 times per month the following types of food: 431 (47.3%) consume fish and seafood and 321 (35.2%) consumes dried nuts.

It is important to note that a significant number of the participants never consume some types of food: 559 participants never consume other types of lipid except olive oil (e.g., butter, margarine, etc.), 216 (23.7%) participants never consume dried nuts, 134 (14.7%) participants never consume eggs, 103 (1.3%) participants never consume soft drinks και 83 (9.1%) participants never consume fast food. It is also important to note that the consumption of fish and seafood is divided between the individuals that consume them 1-2 per month (N=431, 47.3%) and those that consume them more often, 1-2 per week (N=376, 41.2%). Finally, 71 (7.8%) of the participants stated that they consume sweets more than one time per day.

**Table 2 – Consumption Frequency of Different Types of Nutrients**

FOOD TYPE	Never/ Rarely	1-2 Times/ Month	1-2 Times/ Week	3-6 Times/ Week	Daily
<b>Bread and Cereals</b>	-	1.3%	16.0%	28.7%	54.0%
<b>Legumes</b>	2.7%	23.1%	66.9%	6.3%	1.0%
<b>Potatoes</b>	2.9%	24.5%	53.8%	16.2%	2.7%
<b>Fruits</b>	0.2%	0.9%	12.9%	39.0%	47.0%
<b>Vegetables</b>	-	1.9%	22.5%	38.0%	37.6%
<b>Nuts</b>	23.7%	35.2%	26.5%	8.4%	6.1%
<b>Fish &amp; Seafood</b>	7.5%	47.3%	41.2%	3.0%	1.1%
<b>Meat and Meat Products</b>	2.0%	10.0%	65.9%	17.4%	4.7%
<b>Milk &amp; Dairy Products</b>	1.4%	4.3%	15.9%	37.5%	40.0%
<b>Eggs</b>	14.7%	30.0%	41.3%	11.0%	2.9%
<b>Olive Oil</b>	2.1%	2.5%	2.4%	6.1%	86.9%
<b>Other Lipids</b>	61.3%	16.6%	13.5%	5.8%	2.9%
<b>Alcoholic Drinks</b>	16.1%	22.7%	28.3%	17.0%	15.9%
<b>Soft Drinks</b>	11.3%	20.2%	27.0%	23.0%	18.5%
<b>Coffee &amp; Tea</b>	3.2%	5.0%	13.6%	16.3%	61.8%
<b>Traditional Cooked Dishes</b>	0.7%	28.8%	55.9%	10.5%	4.1%
<b>Fast Food or Junk Food</b>	9.1%	30.3%	35.2%	15.5%	10.0%
<b>Sweets</b>	1.3%	13.2%	32.2%	23.2%	30.1%

The risk levels for developing non-communicable diseases are presented in Table 3. From the primary data collected it becomes evident that a large part of the population of the Municipality of Laconia faces problems related to all the systems of the organism studied. More specifically, the number of individuals that have a high risk for developing non-communicable diseases and anomalies include: 148 (16.2%) have problems related to the upper gastrointestinal system, 56 (6.1%) to the liver and gallbladder, 78 (8.6%) to the small intestines, 36 (3.9%) to the large intestines, 26 (2.9%) to the lack of minerals, 378 (41.4%) to the lack of essential amino acids, 338 (37.1%) to carbohydrate metabolism, 138 (15.1%) to lack of vitamins, 220 (24.1%) to the adrenal glands, 142 (15.6%) to the hypophysis, 190 (20.8%) to the thyroid, 188 (20.6%) to the cardiovascular system, 152 (16.7 to the kidneys and bladder, και 72 (7.9%) to the immune system, while 24 (5.4%) men have andrologic problems, 110 (23.7%) women have gynaecologic problems,.

The number of individuals that have a moderate risk for development of diseases and anomalies include: 196 (21.5%) have problems related to the upper gastrointestinal system, 138 (15.1%) to the liver and gallbladder, 144 (15.8%) to the small intestines, 126 (13.8%) to the large intestines, 80 (8.8%) to the lack of minerals, 224 (24.6%) to the lack of essential amino acids, 200 (21.9%) to the carbohydrate metabolism, 192 (21.1%) to lack of vitamins, 186 (20.4%) to the adrenal glands, 318 (34.9%) to the hypophysis, 166 (18.2%) to the thyroid, 186 (20.4%) h to the cardiovascular system, 122 (13.4%) to the kidneys and bladder, και 286 (31.4%) to the immune system, while 26 (5.8%) men have andrologic problems, 124 (26.7%) women have gynaecologic problems.



**Table 3 – Risk levels for developing non-communicable diseases:-**

<b>SYSTEMS</b>	<b>Low Risk</b>	<b>Moderate Risk</b>	<b>High Risk</b>
<b>Upper Gastrointestinal System</b>	62.3%	21.5%	16.2%
<b>Liver and Gallbladder</b>	78.7%	15.1%	6.1%
<b>Small Intestines</b>	75.7%	15.8%	8.6%
<b>Large IntestinesP</b>	82.2%	13.8	3.9%
<b>Mineral Needs</b>	88.4%	8.8%	2.9%
<b>Necessary Amino Acids</b>	34.0%	24.6%	41.4%
<b>Carbohydrate Metabolism</b>	41.0%	21.9%	37.1%
<b>Vitamin Needs</b>	63.8%	21.1%	15.1%
<b>Adrenal</b>	55.5%	20.4%	24.1%
<b>Hypophysis</b>	49.6%	34.9%	15.6%
<b>Thyroid</b>	61.0%	18.2%	20.8%
<b>Andrologic</b>	88.8%	5.8%	5.4%
<b>Gynaecologic</b>	49.6%	26.7%	23.7%
<b>Cardiovascular System</b>	59.0%	20.4%	20.6%
<b>Kidneys and Bladder</b>	70.0%	13.4%	16.7%
<b>Immune System</b>	60.7%	31.4%	7.9%

As far as the registered health problems are concerned the participants stated the following: 257 (28.2%) have high levels of cholesterol and 164 (18.0%) have levels of triglycerides, while 43 (4.7%) suffer from diabetes, 52 (5.7%) suffer from hyperthyroidism, 125 (13.7%) suffer from hypothyroidism, 50 (5.5%) suffer from kidney problems, 45 (4.9%) suffer from respiratory problems, 27 (3.0%) have emphysema, 60 (6.6%) have asthma, 75 (8.2%) have arthritis, 58 (6.4%) have osteoporosis, 58 (6.4%) suffer from cholelithiasis, 6 (0.7%) suffer from pancreatitis, 19 (2.1%) suffer from liver problems, 11 (1.2%) have suffered from myocardial infarction, 11 (1.2%) have suffered from cardiac attack, 2 (0.2%) have suffered from stroke, 20 (2.2%) have suffered from other cardiovascular problems, 18 (2.0%) have suffered from cancer, 4 (0.4%) suffered from epilepsy, 4 (1.0%) suffered from prostate cancer, and 4 (0.4%) suffered from multiple sclerosis.

#### **Comparisons between groups:-**

There were statistically significant differences among the different parameters studied with respect to different demographic characteristics studied.

**Sex:** men ( $2.84 \pm 0.64$ ) consume more legumes than women [ $2.75 \pm 0.62$ ,  $t(910) = 2.24$ ,  $p = 0.025$ ]; men ( $3.00 \pm 1.10$ ) consume more fast food than women [ $2.75 \pm 1.10$ ,  $t(910) = -3.52$ ,  $p = 0.0005$ ]; men ( $4.39 \pm 0.92$ ) consume less fruits than women [ $4.53 \pm 0.94$ ,  $t(910) = -2.19$ ,  $p = 0.029$ ]; men ( $2.47 \pm 1.03$ ) consume less eggs than women [ $2.70 \pm 0.97$ ,  $t(910) = -3.53$ ,  $p = 0.0005$ ]; men ( $1.54 \pm 0.89$ ) consume less butter or margarine than women γυναικών [ $1.90 \pm 1.21$ ,  $t(910) = -5.12$ ,  $p = 0.222$ ]; men ( $4.43 \pm 1.33$ ) consume less coffee and other beverages than women [ $4.8 \pm 1.30$ ,  $t(910) = -2.84$ ,  $p = 0.0005$ ]; and, men ( $3.66 \pm 1.20$ ) consume less sweets than women [ $3.84 \pm 1.20$ ,  $t(910) = -2.35$ ,  $p = 0.019$ ].

**Marital Status:** single individuals ( $3.25 \pm 0.95$ ) consume more meat and meat products than married individuals [ $3.11 \pm 0.70$ ,  $t(910) = 1.84$ ,  $p = 0.029$ ]; single individuals ( $3.14 \pm 1.10$ ) consume more fast food than married individuals και παντρεμένων [ $2.81 \pm 1.10$ ,  $t(910) = -3.72$ ,  $p = 0.0005$ ]; single individuals ( $3.60 \pm 1.37$ ) consume more soft drinks than married individuals [ $3.11 \pm 1.30$ ,  $t(910) = 4.64$ ,  $p = 0.0005$ ]; single individuals ( $5.01 \pm 1.16$ ) consume less olive oil than married individuals [ $5.29 \pm 1.05$ ,  $t(910) = -3.23$ ,  $p = 0.001$ ]; and, single individuals ( $2.20 \pm 1.12$ ) consume less nuts than married individuals [ $2.44 \pm 1.13$ ,  $t(910) = -2.598$ ,  $p = 0.010$ ].

**Age Group:** the 35-44 age group ( $4.35 \pm 0.98$ ) consumes less fruits than the 45-54 age group [ $4.59 \pm 0.91$ ,  $F(2, 910) = 16.706$ ,  $p = 0.0005$ ]; the 35-44 age group ( $5.03 \pm 1.23$ ) consumes less olive oil than the 45-54 ( $5.29 \pm 0.93$ ), and the 55-65 age group [ $5.36 \pm 1.03$ ,  $F(2, 910) = 0.056$ ,  $p = 0.0005$ ]; the 35-44 age group ( $1.83 \pm 1.11$ ) consumes more alcoholic beverages than the 45-54 ( $1.74 \pm 1.10$ ), and the 55-65 age group [ $1.60 \pm 1.01$ ,  $F(2, 910) = 8.186$ ,  $p = 0.0005$ ]; the 35-44 age group ( $3.28 \pm 0.74$ ) consumes more meat than the 45-54 ( $3.21 \pm 0.75$ ), and the 55-65 age group

[2.94±0.78, F(2, 910)=16.706, p=0.0005]; the 35-44 age group (4.30±0.98) consumes more milk and dairy products than the 45-54 (4.28±1.04), and the 55-65 age group [4.06±1.13, F(2, 910)=5.260, p=0.0005]; the 35-44 age group (2.77±1.01) consumes more eggs than the 45-54 (2.63±0.97), and the 55-65 age group [2.36±0.99, F(2, 910)=13.222, p=0.0005]; the 35-44 age group (1.83±1.11) consumes more butter and margarine than the 45-54 (1.74±1.10), and the 55-65 age group [1.60±1.01, F(2, 910)=3.590, p=0.0005]; the 35-44 age group (3.34±0.96) consumes more fast food than the 45-54 (2.88±0.63), and the 55-65 age group [2.41±0.71, F(2, 910)=60.225, p=0.0005]; the 35-44 age group (3.55±1.28) consumes more soft drinks than the 45-54 (3.29±1.37), and the 55-65 age group [2.80±1.25, F(2, 910)=25.824, p=0.0005]; the 35-44 age group (4.46±1.47) consumes less coffee and tea than the 45-54 (4.76±1.23), but the same with 55-65 age group [4.46±1.32, F(2, 910)= 5.334, p=0.0005]; and, the 35-44 age group (3.99±1.20) consumes more sweets than the 45-54 (3.53±1.10), and the 55-65 age group [3.75±1.20, F(2, 910)=11,248, p=0,0005].

**Educational Level:** high school graduates (4.15±0.94) consume less vegetables than undergraduates (4.18±0.91) and postgraduates [4.46±0.99, F(2, 910)=3.255, p=0.039]; high school graduates (2.25±1.04) consume less dried nuts than undergraduates (2.46±1.19) and postgraduates [3.04±1.22, F(2, 910)=17.396, p=0.0005]; high school graduates (2.80±0.01) consume less fast food than undergraduates (2.83±1.22) and postgraduates [3.01±1.25, F(2, 910)=3.368, p=0.035]; high school graduates (2.98±0.77) consume more potatoes than undergraduates (2.84±0.80) and postgraduates [2.82±1.08, F(2, 910)=3.713, p=0.025]; high school graduates (2.48±0.74) consume more fish/seafood than undergraduates (2.46±0.87) and postgraduates [2.34±0.64, F(2, 910)=3.512, p=0.030]; high school graduates (5.31±0.98) consume more olive oil than undergraduates (5.11±1.20) and postgraduates [5.19±1.17, F(2, 910)=3.583, p=0.028]; high school graduates (2.94±0.76) consume more traditionally cooked dishes of the Greek cuisine than undergraduates [2.80±0.79, F(2, 910)=3,143, p=0,044]; and, high school graduates (4.68±1.27) consume less coffee and tea than undergraduates (4.42±1.36, F(2, 910)=5326, p=0005].

**Employment Status:** farmers (2.98±0.71) consume more legumes than private sector employees (2.73±0.62), self-employed individuals (2.71±0.61), and civil servants [2.69±0.65, F(2, 910)=7.824, p=0.0005]; farmers (3.12±0.85) consume more potatoes than civil servants [2.73±0.86, F(2, 910)=4,880, p=0,001]; civil servants (2.94±0.70) consume more than farmers (2.44±0.85), self-employed individuals (3.23±0.77), and private sector employees [2.41±0.73, F(2, 910)=12,139, p=0,0005]; civil servants (4.49±0.95) consume more milk/dairy products than farmers (4.02±1.11) and private sector employees [4.26±1.15, F(2, 910)=4,707, p=0,001]; and, private sector employees (3.39±1.05) consume more frequently fast food than self-employed individuals (2.78±1.1), civil servants [2,82±0.85, F(2, 910)=13,799, p=0,0005].

**Residential Zone:** residents in rural areas (2.91±0.69) consume more legumes than residents of urban (2.75±0.59) and semi-urban areas [2.67±0.61, F(2, 910)=9.593, p=0.0005]; residents in rural areas (3.08±0.84) consume more potatoes than residents of urban (2.86±0.81) and semi-urban areas [2.76±0.71, F(2, 910)=11.007, p=0.0005]; residents in rural areas (4.68±1.18) consume more coffee/ tea than residents of urban (4.56±1.32) and semi-urban areas [4.37±1.41, F(2, 910)=3.121, p=0.045]; residents in rural areas (5.36±0.90) consume more olive oil than residents of urban (5.16±1.12) and semi-urban areas [5.12±1.27, F(2, 910)=4.279, p=0.014]; residents in rural areas (4.16±1.00) consume less milk/dairy products than residents of urban [4.34±1.07, F(2, 910)=5.070, p=0.006]; residents in rural areas (2.79±0.76) consume less traditional dishes than residents of urban [2.81±0.72, F(2, 910)=9.261, p=0.0005]; and, residents in rural areas (2.26±1.06) consume less nuts than residents of urban [2.50±1.22, F(2, 910)=11.100, p=0.0005].

#### **Multiple Regression Analysis – Determinants of Risk Levels for Development of non-Communicable Diseases**

A multiple regression equation was identified for each of the 16 systems studied. The r-squared and standardised beta values are presented in Table 4. From the analysis it becomes evident that sex is a contributing factor for all systems studied, and women face greater risks than men. BMI is also a major determinant and affects risk in all systems studied except the large intestines and kidney/bladder, and the greater the BMI the greater is the risk. Age is also a determinant for seven of the systems studied with mixed results.

Fish and seafood decrease the risk in all systems studied except the immune systems and the needs in minerals. Vegetables decrease the risk in the upper gastrointestinal system, the regulation of the metabolism of sugars, the needs in amino acids and the kidneys and the bladder, while fruits reduce the risk for andrologic problems, needs for amino acids and the kidneys and the bladder. Milk and dairy products reduce the risk associated with the liver and the gallbladder, the small intestines and the essential amino acids. Traditional cooked dishes of the Greek Cuisine increase the risks associated with all the systems except the needs for vitamins, the hypophysis, the immune system



and the gynaecologic and andrologic problems. Fast food or junk food increases the risk associated with all the systems except the needs for minerals and vitamins, the hypophysis, the thyroid and the kidneys and bladder. Eggs increase the risk associated with all systems except the upper gastrointestinal system, the small and large intestines, the essential amino acids, carbohydrate metabolism, and gynaecologic problems. Bread and cereals increase the risk associated with carbohydrate metabolism and the cardiovascular system. Dried nuts increase the risk for the liver and the gallbladder, the carbohydrate metabolism and the immune system. Sweets increase the risks associated with the needs for minerals, the carbohydrate metabolism and the thyroid, while they lower the risk for andrologic problems. Alcoholic drinks increase the risks associated with the metabolism of sugars, and the cardiovascular system and decrease it for the thyroid. Coffee and tea have beneficial effects for the immune system. Potatoes lower the risks associated with the essential amino acids, while they increase it in the upper gastrointestinal system and the immune system. Legumes lower the risk for the upper gastrointestinal system and increase it for the adrenal glands. Meat decreases the risk for the large intestines and increases it for vitamin needs. A paradox that is observed is related to other lipids (e.g., butter, margarine, etc.), which seem to reduce the risks associated with the needs for essential amino acids, vitamin needs, the hypophysis, the thyroid and the cardiovascular system. Possibly this is attributed to the fact that the residents of the Municipality of Laconia in their majority do not consume butter or margarine and restrict their lipid intake to olive oil. Small amounts of such lipids in the diet may have a beneficial effect.

Table 4 – Multiple Regression Analysis of Nutrient Types vs. Risk Levels for Each System

	R <sup>2</sup> (p<0.0005)	AGE	BMI	SEX	BREAD & CEREALS	LEGUMES	POTATOES	FRUITS	VEGETABLES	NUTS	FISH & SEAFOOD	MEAT & MEAT PRODUCTS	MILK & DAIRY PRODUCTS	EGGS	OLIVE OIL	OTHER LIPIDS	ALCOHOLIC DRINKS	SOFT DRINKS	COFFEE & TEA	TRADITIONAL COOKED DISHES	FAST FOOD	SWEETS	
					Standardised Beta																		
Upper Gastrointestinal System	0.130	-0.075	0.210	0.173		-0.089	0.085			-0.092						0.077				-0.076		0.161	0.082
Liver and Gallbladder	0.132		0.109	0.236						0.101	-0.130			-0.086	0.101	0.105						0.233	0.462
Small Intestines	0.104	-0.077	0.144	0.200							-0.130			-0.098								0.079	0.105
Large Intestines	0.075	0.074		0.163							-0.125	-0.085										0.125	0.152
Mineral Needs	0.103		0.042	0.253										0.122								0.125	0.092
Necessary Amino Acids	0.157		0.172	0.297			-0.079	-0.122	-0.074		-0.113		-0.069			-0.084						0.115	0.106
Carbohydrate Metabolism	0.135		0.165	0.234	0.067					-0.099	0.101	-0.149					0.087					0.139	0.073
Vitamin Needs	0.094		0.147	0.175							-0.152	0.100		0.111		-0.071						0.113	
Adrenal	0.072		0.095	0.216		0.081					-0.100			0.089								0.097	0.073
Hypophysis	0.116		0.136	0.300							-0.096					-0.085							
Thyroid	0.132		0.173	0.310							-0.161			0.073		-0.086	-0.115					0.115	0.077
Andrologic	0.137	0.160	0.100					-0.141						0.189								0.103	-0.108
Gynaecologic	0.111		0.176								-0.204											0.124	
Cardiovascular System	0.126	0.108	0.209	0.274	0.146						-0.118			0.119	0.116	-0.105	0.092					0.098	0.087
Kidneys and Bladder	0.081		0.174					-0.095	-0.096		-0.206			0.113								0.093	
Immune System	0.067		0.083	0.115			0.106			0.078				0.083						-0.070	-0.067		0.126

## Discussion:-

The majority of the inhabitants of Laconia consume very often or everyday vegetables fruits, grains/pastries, milk/milk products (e.g., cheese, yogurt, etc.), olive oil, coffee/herbal teas and pastries. Also, 1-2 times a week they consume legumes, meat, poultry and sausages, eggs, potatoes, traditional dishes (e.g., moussaka, pastitsio, etc.), fast food (e.g., toast, delivery, etc.) and non-alcoholic refreshments. More rarely, 1-2 times a month they consume fish/seafood and dried nuts. Men consume more legumes and fast food than women, while women consume more fruits, eggs, butter or margarine, coffee and other beverages and sweets. Single individuals consume more meat and meat products, fast food and soft drinks than married individuals, while the latter consume more olive oil and nuts. The consumption of fruit, olive oil and alcoholic beverages increases as age increases, while consumption of meat, milk and dairy products, eggs, butter and margarine, fast food and soft drinks decreases. The consumption of coffee and other beverages increases in the middle age range and reverts to the original levels at the older range, while eating sweets decreases in the middle age range and then increases in the older range without, however, reaching the original levels. In terms of educational level, consumption of vegetables, dried nuts, fast food increases as education level increases, while consumption of potatoes, fish/seafood, olive oil, traditional dishes and coffee decreases. Farmers consume more legumes and potatoes from the rest, while civil servants consume more meat and milk/dairy products from the rest. Private sector employees are the ones that more frequently consume fast food. Residents in rural areas consume more legumes, potatoes, coffee/herbal teas and olive oil compared to individuals from urban and semi-urban areas, while they consume less milk/dairy products, traditional dishes and nuts. From the data collected it seems that the residents of the Municipality of Laconia continue to apply the principles of the Mediterranean diet, however they deviate from its principles by integrating more frequently in their diet more meat and meat products, traditional cooked dishes and fast food or junk food.

The results for obesity levels raise serious concerns about the future of the inhabitants of Laconia and the evolution of their disease spectrum, as recorded details show that 37.6% of the inhabitants of Laconia are overweight, 19.5% are obese and 1.3% are morbidly obese and just 40.9% of them are normal weight. Also, the average BMI that was recorded was  $26.75 \pm 4.53 \text{ kg/m}^2$ , which is above the limit of  $25 \text{ kg/m}^2$ .

The primary data indicates that the inhabitants of Laconia face problems and high risk to develop non-communicable diseases in all systems of the organism studied. Almost one third of the population studied faces relatively high risk levels for the development of non-communicable diseases that are associated with the upper gastrointestinal, the cardiovascular, the gynaecological and the immune systems, the adrenal, pituitary, and the thyroid glands, the metabolism of carbohydrates and the regulation of amino acids.

The findings show a strong correlation between diet and the risk of developing problems/ diseases in all body systems. Fish and seafood reduce the risk in almost all systems studied. On the contrary, the increased consumption of eggs, cooked traditional dishes and fast food or junk food, seems to increase the risk significantly in almost all systems studied. Fruits and vegetables and milk/dairy seem to have a positive effect, results appear mixed for grains/pastries, legumes, potatoes, meats and alcoholic drinks and a negative influence is observed for the sweets.

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The findings of the current survey are in line with the conclusions of the European Prospective Investigation of Cancer and Nutrition (EPIC-Norfolk), conducted in the period 1994-1999 in regions around the Greek State. This programme explored the daily consumption of food and drinks and daily energy intake and nutrients in a large sample of the Greek population ( $N=28,572$  Greeks – 11,954 men and 16,618 women) aged 20-85 years from all socio-economic strata. The study demonstrated the high consumption of vegetables, fruits, cereals, meat, milk and dairy products from the Greek population and a clear preference in the use of olive oil as a source of lipids. The programme confirmed the gradual moving away of the population from the traditional Greek and Mediterranean diet. According to the study, Greeks consume greater amounts of red meat and smaller amounts of vegetables, legumes and fruits than recommended and do not exercise regularly. This makes them more prone to developing diseases associated with obesity [25].

Large epidemiological studies carried out with different groups of the population, have shown a strong correlation between a greater adherence to the Mediterranean diet, and decreased risk of mortality and impact of major chronic diseases [26]. In this context, the return to the Mediterranean diet is one effective approach for preventing nutrition-related non-communicable diseases. The specifications of the Mediterranean include: (i) abundant consumption of plant foods (e.g., fruits, vegetables, breads, other forms of cereals, beans, nuts and seeds); (ii) consumption of non-processed foods, fresh and in season, grown in the area; (iii) fresh fruit as the typical daily dessert, sweets based on nuts, olive oil, and sugar or honey consumption only during the holidays; (iv) consumption of olive oil as the main source of dietary lipid; (v) consumption of dairy products (principally cheese and yogurt) in low to moderate amounts; (vi) consumption of fewer than four eggs a week; (vii) red meat consumption with low frequency and in small quantities; and (viii) consumption of wine in low to moderate amounts, especially with meals [27].

### **Limitations:-**

The investigation was based mainly on recall questionnaires. Many scientists have raised doubts about the effectiveness of recall questionnaires [28] due to the reduced memory of the participants or the deliberately incorrect answers that may be given, as many of the items listed can be considered interference in personal life or personal data, and may lead to wrong conclusions. Also, the questionnaire that was developed for the survey made extensive use of scientific terminology, although attempts were made to make its language as simple as possible. However, in many cases it had to be filled out by the participants with the help of the researcher in order to avoid mistakes.

The individual questionnaire for the assessment of the physical activity levels and the one for the assessment of the non-communicable risk factors have been used separately in many surveys. However, they have never been used in conjunction for finding associations between frequency of consumption of different types of nutrients and non-

communicable disease risk factors. This creates doubts as to their effectiveness in capturing the correct data required and whether these correspond to the reality.

Finally, the low level of andrologic problems reported possibly do not reflect reality, as many Greek men tend to hide problems related to their genitals because they are ashamed, and generally they are reluctant to speak about problems related to them.

### **Conclusion:-**

All individuals must be oriented towards adopting a healthy lifestyle, which involves a proper diet and regular exercise, to lower the risk for development of many non-communicable diseases. The ideal would be to adopt this healthy lifestyle from childhood and throughout life. The Mediterranean diet has been identified as optimal for the prevention of non-communicable diseases and maintaining good health. As the population of Laconia is experiencing serious health problems, the return to the traditional Greek and Mediterranean diet should be a key objective of all stakeholders.

The findings of the current research showed a significant impact of the frequency of consumption of different types of nutrients on the risk for development of non-communicable diseases that involve 16 systems of the human organism studied. However, further research is needed to analyse the relationship between specific types of nutrients and specific problems that can develop in the human body and the frequency of consumption may not by itself be a unique determinant. There is also a need for research that includes other regions of the Greek territory, so that comparisons can be made, enabling more in-depth generalisations to the wider population of Greece.

### **Competing interests:-**

The authors report no conflict of interest in the reporting of the data.

### **Authors contribution:-**

The research was conducted by Panagiotis Basourakos as part of his Ph.D. thesis for the University of Peloponnese, under the direct supervision of Prof. Apostolos Stergioulas. Prof. Alexandara Tripolitsioti and Dr. Stamatios Mourtakos had an advisory role in the conduct of the research, and reviewed and edited the article that is submitted for publishing.

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