Meat consumption patterns and the body mass index in the population of Dalmatia

Lundström, Josefin

UNIVERSITY OF SPLIT

SCHOOL OF MEDICINE

Josefin Lundström

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Diploma Thesis

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1. INTRODUCTION

A high body mass index (BMI) is one of the most alarming risk factors leading to chronic diseases like hypertension, diabetes mellitus type 2, dyslipidemia and coronary artery disease. The burden of a high BMI is not only immense, but also increasing. The reasons for this are several fold and include less time spent performing physical activity, a more abundant offer to buy low-priced foods that are energy-dense and influence of food industries (1).

Many attempts have been made to decrease obesity and encourage a healthier life-style, like banning television commercials of unhealthy foods and taxation of drinks with added sugars. However there is only weak evidence that this has had any impact on the current BMI trend (1).

This increase in prevalence of obese people is no longer only a problem in the USA. In 113 countries in 2016 the leading risk factor of disability-adjusted life years (DALYs) was a metabolic one. In addition to that, a suboptimal diet was found to be the second leading risk factor for deaths and DALYs globally, accounting for almost one fifth (18.8%) of all deaths and 9.6 % of all DALYs. Over half of deaths and DALYs connected to a suboptimal diet were caused by cardiovascular diseases (1).

Numerous risk factors like smoking and unsafe sanitation have been reduced in the last decades (since 1990), while metabolic risk factors have increased. High blood pressure was the fourth leading risk factor in terms of DALYs for men and women in 1990; by 2016 it had risen to become the second leading risk factor for men and first for women (1). The same tendency can be found for other metabolic risk factors, such as already mentioned high BMI, high fasting plasma glucose and high total cholesterol. The greatest rise in deaths and DALYs from 1990–2016 that were due to metabolic risk factors can be attributed to a diet high in red meat (1).

Several studies have also been able to identify that red meat is probably carcinogenic for humans. It is mainly a risk factor for colorectal cancer, but there is also a link between the consumption of red meat and the development of pancreatic and prostate cancer (2). Processed meat is found to be even more carcinogenic than red meat (3).

There are several forms of malnutrition: undernutrition, over nutrition and poor dietary habits. But amongst these a low intake of healthy food is the leading risk factor for mortality (4).

In this study, we will investigate the patterns of meat consumption in a population that is assumed to adhere to the Mediterranean diet. Furthermore, we will look for the association between consumption of different types of meat and anthropometry indices (BMI).

1.1. Mediterranean Diet

The Mediterranean Diet is an eating pattern that has its origin in the Mediterranean countries like Greece, Italy and Spain. A large number of studies conducted over many years have concluded that adhering to a Mediterranean diet leads to several health benefits. It decreases the risk of cardiovascular diseases, lowers the cholesterol levels, decreases BMI, improves cognitive health, decreases the risk of developing diabetes mellitus type 2 and even decreases the risk of developing several types of cancer (5). One study even suggests that the Mediterranean diet has "anti-inflammatory" features which can improve symptoms of asthma (6).

Mediterranean diet has been defined and scored by many different approaches and using diet pyramids, general descriptions and various forms of scoring systems. A key element of this dietary pattern is a low intake of saturated fat, and instead a high intake of vegetable oils (7).

Furthermore, the Mediterranean diet is composed of a high intake of vegetables, fruits, nuts and whole grains while it suggests the moderate consumption of red wine and legumes. The recommendation of a low intake of milk, a high intake of cheese and yoghurt and moderate intake of products like fish and eggs are other cornerstones of this dietary pattern. In addition to that, the Mediterranean diet suggests only a low consumption of red and processed meat (8).

1.2. Western Diet

The Industrialization in the 18th and 19th century brought with it many changes for human beings. It led to urbanization, population decline and prosperity for the industrialized countries. It also affected the dietary patterns in many ways. Especially food-processing methods that were introduced with the Industrialization changed the dietary style. It brought about foods with a higher glycemic load and fatty acid contents and led to production of the energy-dense foods, meals with decreased fiber-content and changed acid-base balance and

sodium-potassium ratios. It is believed that in this lies the root of many chronic diseases patients have to face today (9).

The paper "Origins and evolution of the Western diet: health implications for the 21st century" from 2005 even suggests that human's "ancient genome" wasn't prepared for the "nutritional qualities" of those newly introduced nutritional patterns and that this has led to several of the chronic diseases of the Western world (10).

Keystone of a so-called Western diet is the intake of high amounts of both red and processed meats. Furthermore, a high intake of butter, dairy products, eggs, refined grains, drinks with high sugar contents, and the moderate to low intake of vegetables, fruits and legumes are all components of the Western diet (11).

1.3. Recommended Diet

A healthy and balanced diet helps the body to protect itself against various forms of malnutrition and non-communicable diseases, such as hypertension, stroke, cancer and diabetes mellitus. However, defining the term "healthy diet" is a challenging task. It depends on the needs of each individual and factors like age, gender, degree of physical activity and lifestyle, which all play a great role. Nonetheless, the World Health Organization has put together some basic guidelines that make up a healthy diet (12).

A grown human being should consume about 30–50 g of protein daily, in order to keep up with the metabolism. 20–30 g of body proteins are degraded daily and utilized in order to build other molecules that body needs. This is why cells need to produce new proteins constantly, and the body needs the intake of proteins in the daily diet (13).

The World Health Organization recommends a fat intake which should not exceed 30% of the total energy intake. Furthermore, it is recommended to consume unsaturated rather than saturated fats. In order to prevent diseases like hypertension, WHO further suggests limiting salt intake to under 5 g daily. Salt restriction could prevent 1.7 million deaths yearly (14). Additionally, the consumption of "free sugars" should be restricted to under 10% of total energy intake, which amounts to less than 50 g daily. A healthy diet is further defined as the one which is composed of at least five portions of fruits and vegetables daily (400 g). This

intake could lead to a decrease in non-communicable diseases and it provides the human body with sufficient amounts of fiber (12).

1.4. Importance of proteins in diet

Regular ingestion of proteins, carbohydrates and fats in our diet give us the energy we need for different body functions. A balanced energy intake and expenditure leads to stability in bodyweight. Overfeeding, which is defined as an energy intake that is higher than energy expenditure, leads to an energy surplus, which is then stored mostly as fat and eventually increases body weight. Accordingly, an energy intake, which is lower than the daily bodily metabolic needs, leads to a decrease in body weight (13).

The average American obtains about 15% of his/her energy from protein, 40% from fat and 45% from carbohydrates. In many non-Western countries, the sum of the energy obtained from carbohydrates exceeds that derived from protein and fat by far (13).

Meat products are known to have a high protein and a low carbohydrate content, especially compared to vegetables or potatoes. An average lamb leg for example contains 18% proteins, 17.5% fat and 1% carbohydrates, whereas oranges contain 0.9% proteins, 0.2% fat and 11.2% carbohydrates (13).

"Partial proteins" are proteins that have scarce amounts of certain essential amino acids. Proteins in animal products like meat are said to be "more complete" than proteins from vegetables and grains. An example is the lack of tryptophan (which is an essential amino acid) in corn. Even though corn contains 10% of protein its lack of this essential amino acids leads to the development of the protein deficiency kwashiorkor in low-income countries, where people use cornmeal as their main protein source (13).

In countries like the USA, Spain and France the prevalence of people living on a vegetarian diet is under 4%, so in these regions a high number of people derive their main share of protein from meat products (15).

1.5. Industrialization as a source of today's chronic diseases

The yearly medical costs of obesity are assumed as high as 147 billion $. Several papers suggest that the origin of the obesity epidemic lies in the developments that happened around the period of Industrialization (9).

Industrialization was an era of change, both socially and economically. It comprises the transition from an agrarian society to an industrial one by technical and economical innovations replacing manual labor and ending up in a manufacturing society with mass production and dissemination of new ingredients (16).

The arrival of affordable fossil fuels, mechanization of farming and the development of infrastructure that led to an easier distribution of products are important features of Industrialization. Agriculture in a way created a situation that a typical American farm today no longer produces many different products, but is specialized to produce a limited variety of products (9).

In particular, food staples and food processing procedures gave rise to a switch of the diet that had been known to humans in the time before the Industrialization. It led to a change in glycemic load, fatty acid composition, macronutrient composition, micronutrient density, acid-base balance and fiber content. New foods that appeared with Industrialization were cereals, refined cereals, refined sugars, dairy products, refined vegetable oils, fatty meats and salt. Theories have emerged that claim that the "ancient human genome" was stunned by these new compositions of foods which could be the source of many of today's chronic diseases, like obesity, diabetes and hypertension (10).

1.6. Obesity: Epidemiology and burden of disease

There are two definitions of overweight and obesity by the WHO. On the one hand, they are defined as a BMI over or equal to 25 kg/m^2, and as a BMI over or equal to 30 kg/m^2, respectively. On the other hand, overweight and obesity are considered as "abnormal or excessive fat accumulation that may impair health " (17). BMI is a very practical measure of overweight and obesity in adults, because it is applicable to all adults indifferent of age and sex. Nonetheless it should be treated with a certain degree of caution since it only offers a first estimate and it doesn't measure actual body fat (17).

In the last 40 years, obesity has more than doubled. Over 1.9 billion adults were overweight worldwide in 2016; of which more than 650 million had a BMI over 30, i.e. were obese. In total 13% of all adults worldwide in 2016 were obese (17).

Notably most people today live in countries where being overweight and obese leads to more deaths than being underweight (exception to this are parts of sub-Saharan Africa and Asia). Furthermore, an increase in BMI is related to more deaths globally than being underweight. This is especially concerning and worth mentioning since being overweight and obese are considered preventable states (17). There are several health consequences of an increased amount of body fat. A BMI over 25 kg/m^2 is a large risk factor for non-communicable diseases like cardiovascular diseases, diabetes, musculoskeletal disorders, several cancers, e.g. breast, prostate, liver and colon cancer. There is a direct link between these diseases and an increased BMI and the risk increases with increasing BMI (17).

1.7. Cardiovascular disease: Epidemiology and burden of disease

Cardiovascular disease is a spectrum of diseases involving coronary heart disease, cerebrovascular disease, peripheral artery disease, rheumatic and congenital heart disease, deep vein thrombosis and pulmonary embolism (18). Eighty percent of these diseases present themselves as myocardial infarctions or cerebrovascular incidents. Main behavioral risk factors for these non-communicable diseases are smoking tobacco, physical inactivity, too high intake of alcohol and an unhealthy diet (18). 17.7 million people are killed by cardiovascular disease annually which makes up 31% of all deaths worldwide (18).

The prevalence of cardiovascular disease is especially high in low- and middle-income countries. Over 75% of deaths due to cardiovascular disease globally happen in these countries (18). This is because low- and middle-income regions lack means of early diagnosis and therapy of patients with risk factors in contrast to high-income countries. Ergo, cardiovascular disease is diagnosed at a much later stage, when the disease has already progressed. Thus, cardiovascular patients die at an earlier age in low- or middle-income countries than in high-income countries. The death of such a high number of people in their most productive years leads to a massive economic burden in those poorer countries (18).

Life-style changes are the cornerstone of decreasing the risk of cardiovascular disease. Avoiding the aforementioned risk factors by smoking cessation e or reducing salt intake, while increasing intake of fruits and vegetables has proven to decrease the risk of developing cardiovascular disease and can thereby prolong life (18).

1.8. Diabetes: Epidemiology and burden of disease

422 million adults have diabetes and annually 1.6 million deaths are caused by this chronic metabolic disease, which is characterized by an increased level of blood glucose (19). In the last 30 years, the prevalence of diabetes has increased massively in all countries, especially in those of low- and middle-income. In 1980, 108 million people had diabetes, and by 2014, this number had risen to 422 million. The reasons for this drastic rise are several fold and connected to an increased prevalence of obesity and a widespread lack of physical activity (20). The WHO expects that diabetes will be the seventh leading cause of death in 2030 (20). Diabetes is a disease that can affect all people, regardless of age and sex (21). Due to its chronic nature, diabetes has a large impact on quality of life and life expectancy. This leads to a tremendous financial burden both on health care and on families (21).

Next to life style changes like ceasing tobacco use, losing weight and increasing physical activity, a healthy diet is recommended to decrease the burden of diabetes and to prevent or even postpone its onset (22).

1.9. Different kinds of meat and their health benefits/hazards

There is a high variety of meat intake habits globally. The USA and other developed countries consume greater amounts of meat in their diets than developing countries. Nevertheless, developing countries have a rise of meat consumption, since meat intake raises with income (23, 24).

Depending on amount of red or white muscle fibers, meat can be described as red or white meat. Another way to classify meat is whether it is fresh or whether it has been processed by techniques like smoking or salting. Several papers confirm that there has been a change in dietary pattern in the recent years. In the USA, a higher consumption of poultry has been

reported. Despite this development, red meat is still the most consumed meat type in the USA, with almost 25% of this portion being processed (24).

Previous studies from the 1970s and 1980s already found that excessive meat consumption is linked to an increased risk of chronic diseases like cardiovascular disease and cancer (25,26). The part of meat that turns it into a food associated with chronic illnesses like cardiovascular disease is its fat concentration, especially the saturated fat in red meat. In addition to that, meat consumption can lead to the intake of certain mutagens like N-nitroso compounds found in processed meat (27). In 2007, the World Cancer Research Fund/American Institute for Cancer Research report concluded that the association between consuming red or processed meat and developing colorectal cancer was "convincing" (27).

Even though obesity is the major risk factor of developing diabetes mellitus type 2, some dietary patterns are associated with a higher risk than others. A diet rich in processed meats has been found to increase the risk of developing diabetes mellitus type 2 in a cohort study conducted on almost 70.000 women (28).

It is clear that not all kinds of meat bear the same health risks; it depends on factors like the processing methods and on the animal from which the meat comes from (24). Considering the low percentage of vegetarians worldwide, meat is undoubtedly an important source of protein, iron, zinc and B-vitamins for the majority of people (29). Vegetarians deriving these nutrients from plant-based sources are evidently at lower risk for cardiovascular disease, hypertension, cancer, diabetes and obesity. Nevertheless a vegetarian diet low in fat and rich in carbohydrates is not strongly associated with a "decrease in the burden of chronic diseases in the general population" (24).

Meats with a low fat content and meals including fish are recommended for a "balanced, healthy diet" (24). While red meat increases markers of inflammation and oxidative stress, fish consumption has been proven to decrease them (24).

Several studies have investigated the correlation between obesity and meat consumption. One study, for example found that fish-eaters, vegetarians and vegans were less likely to be obese than subjects that ate meat on a regular basis (30).

Another study concluded that populations with a high meat content in their diets had higher rates of obesity and overweight than populations that eat less meat. It is even suggested that meat consumption is the most important predictor of a high BMI (31).

2. AIMS AND HYPOTHESES

2.1. Aims

The aim of this study was to investigate the patterns of meat consumption and to assess the association between consumption of different types of meat and the body mass index (BMI) in a large population-based sample from Dalmatia.

2.2. Hypotheses

1. Subjects who consume processed meat more frequently have increased anthropometric indices, namely higher BMI.
2. Subjects who consume fish on a regular basis have a lower BMI.
3. Older age, male gender, lower education, non-Mediterranean dietary pattern, sedentary behavior, and previously diagnosed chronic diseases are associated with an increase in BMI.

3. MATERIALS AND METHODS

This study is a cross-sectional study, performed within the "10,001 Dalmatians" project (32), and consecutive project "Pleiotropy, genetic networks and pathways in isolated human populations: 10,001 Dalmatian" (HRZZ 8875), which was approved by the Ethical committee of the University of Split Medical School (2181-198-03-04/10-11-0008).

3.1. Subjects

Three subgroups of participants were included. Within the population of the Island of Vis we have enrolled 1027 subjects, from May 2003 till June 2004. From the Island of Korčula we have sampled 2945 subjects (in 2007 and during 2012–2015 period), and from the City of Split we have enrolled 1012 participants (during 2008–2009). The total number of subjects included in this study was 4984.

The only exclusion criterion was age less than 18 years. The convenient sampling approach was used and the call for voluntary participation in the study was announced via local media and local medical doctors.

3.2. Procedures

Weight and height were measured using a standard procedure and subjects were dressed in light clothes. BMI was calculated using the formula:

$$\text{BMI} = \text{weight (kg)}/\text{height}^2 \text{ (m)}$$

Data were collected using an extensive self-administered questionnaire. The questionnaire included the questions on age, gender, socioeconomic status (education), medical history, physical activity, consumption of alcohol, smoking habits, and dietary habits.

Education was assessed by the number of completed years of schooling, and according to this number, subjects were then classified into education groups. Primary education refers to people with ≤8 years of education, secondary education to 9-12 years of education and tertiary education to ≥13 years of education. Previously diagnosed chronic diseases included in the analysis were coronary heart disease, cerebrovascular insult, hypertension, type 2 diabetes, bipolar disorder, cancer, and gout. Regarding smoking habits, subjects could have

answered they are either active smokers, ex-smokers (in case they have ceased more than 1 year ago) or they never smoked.

The level of physical activity was assessed separately for the working part of the day and for the leisure part of the day, either as sitting, light, moderate or intensive. Hence, we have combined those two answers reaching the overall level of physical activity for each subject. Intensive physical was denoted if subject reported it during either part of the day, and the same was done for the moderate level of physical activity. Others were classified as having a light level of physical activity.

Based on alcohol consumption pattern, subjects were classified into one of three groups, as described previously (33):

- no consumption group (subjects who reported to be abstain from all types of alcohol),
- moderate consumption group (1–27 alcohol units/week for men and 1–20 alcohol units/week for women), or
- intensive alcohol consumption (≥28 units/week for men and ≥21 units/week for women)

Types of alcohol that were taken into account included beer, wine, bevanda (a mixture of wine and water) and hard liquor.

3.2.1. Dietary habits, Mediterranean diet and meat consumption

Dietary pattern was assessed using a food frequency questionnaire with 55 questions on typical food items consumed in Dalmatia. For each of those questions subjects could have answered if they consumed that food item on daily basis, 2-3 times a week, once a week, once a month, rarely than once a month or never. The food groups included were fats (olive oil, other vegetable oils, animal fats), milk and dairy products, eggs, meat and meat derivates, fish and seafood, vegetables, fruit, potatoes, cereals, legumes, sweets, non-alcoholic and alcoholic beverages.

Mediterranean diet was assessed based on the responses from the food frequency questionnaire, and according to the methodology described by Monteagudo (34), which was already used in the population of Dalmatia in order to estimate the Mediterranean diet

compliance (35), (33). Shortly, Mediterranean Diet Serving Score (MDSS) was calculated from input of 14 food groups, with a maximum of 24 points, while compliance to the Mediterranean diet is reached in subjects achieving 14 or more points (34). This scoring approach demands high daily intake of vegetables and fruits, cereals and olive oil, moderate daily intake of nuts and milk and dairy products, daily intake of one glass of wine, and weekly intake of legumes, fish, eggs, white meat, potatoes, while intake of red meat and sweets should be kept at a very low frequency – one per week (34).

Meat consumption was assessed separately for fish (both white and blue), white meat (chicken and turkey), red meat (pork and beef), and processed meat (bacon, sausages, salami and processed fish). The frequency of consumption was rated the same way as other food items: on the daily basis, 2-3 times a week, once a week, once a month, rarely than once a month or never. In order to simplify this, we created three groups to assess the frequency of consumption of meat items:

1. weekly consumption, which included both daily intake and 2-3 days a week
2. monthly consumption, which included both once a week and once a month intake
3. rarely or never

Additionally, groups of red meat and processed meat were created. Red meat intake combined pork and beef consumption on the scale of:

1. both pork and beef weekly consumption,
2. consumption of one red meat type weekly,
3. consumption of two types monthly,
4. consumption of one type monthly,
5. rarely or never

Since processed meat group included four types of meat products (bacon, sausages, salami and processed fish), we created five consumption frequency groups:

1. consumption of two or more processed meat types weekly,
2. consumption of one type weekly
3. consumption of two or more types monthly,
4. consumption of one type monthly

5. rarely or never

3.3. Statistical analysis

Categorical variables were described using the absolute number and percentage. Numerical variables were described using the median and interquartile range (IQR), due to non-normal distribution (based on the result of the Kolmogorov-Smirnov test).

The differences between the groups were tested with chi-square test (for categorical variables), and Kruskal-Wallis test for numerical variables.

Additionally, a multivariate binary logistic regression analysis was used in the analysis. Two models were built, one in which BMI≥25 kg/m^2 was dependent variable, and the other one with BMI≥30 kg/m^2 as the dependent variable. In those two models we included 4523 subjects, who had the full set of all the data necessary.

Predictors of interest were various types of meat:

1. fish (group which was consuming fish rarely or never was a referent group),
2. white meat (group consuming chicken and/or turkey rarely or never was a referent group),
3. red meat (group which was consuming red meat rarely or never was a referent group)
4. processed meat (group which was consuming processed meat rarely or never was a referent group).

Both logistic regression models included following confounding variables:

1. gender (men were referent group),
2. age (18-34.9 years was referent group),
3. place of residence (Split was referent group),
4. education level (tertiary education was referent group),
5. chronic disease presence (none was referent group),
6. smoking (those who never smoked were referent group),
7. alcohol intake (those who never drink alcohol were referent group),
8. physical activity (those with intensive physical activity were referent group),
9. Mediterranean diet (those who comply were referent group).

Statistical analysis was performed using the SPSS software (IBM SPSS Statistics, v22). The statistical significance threshold was set to $P<0.05$.

4. RESULTS

The final sample included in this study consisted of 4984 examinees of which 1027 (20.6%) were from the Island Vis, 2945 (59.1%) from the Island Korčula and 1012 (20.3%) came from Split.

Demographic, socioeconomic and life-style characteristics of the sample according to the place of residence are shown in Table 1. Statistically significant difference was found for all those characteristics between the three studied populations (Table 1). There was a statistically significant difference in gender composition (P=0.020; Table 1). Furthermore, we found a difference in the average age and the examinees from Split were the youngest (median age of 52.2 years; IQR 21.0), while the participants from Vis and Korčula were older (56.0 (IQR 24.0) and 55.0 (IQR 23.0), respectively; P<0.001; Table 1). Examinees from the Island of Vis had the lowest prevalence of current smokers; 41.8 % compared to 46.1% in Split and 49.9% in the participants from the Island of Korčula (P<0.001; Table 1). Education measured in years of schooling was lowest in Vis, with median of 11 years of schooling (IQR 4). Participants from Vis had the highest number of reported intensive physical activity (16.4%), while examinees from Split had the lowest prevalence of intensive physical activity (3.7%) (P<0.001; Table 1) and the highest number of reported light physical activity (35.7%). Examinees from Korčula had the highest number of reported moderate physical activity (69.4%) (P<0.001; Table 1). Regarding alcohol consumption, we found most examinees who reported moderate alcohol intake in Split (47.3%), compared to 45.5% on Korčula and 43.4% on Vis. We found Vis to have the population with most non-drinkers, where 41.3% of examinees reported to drink no alcohol at all, followed by Split with 39.7% and Korčula with 35.1% (P<0.001; Table 1). Mediterranean diet compliance was highest on Vis (31.1%), and lowest on Korčula (27.4%) (P=0.036; Table 1). Examinees with the highest BMI were found to come from the Island of Vis, with a median BMI of 27.1 kg/m^2 (IQR: 6.1), while examinees from Korčula had the lowest median BMI of 24.7 kg/m^2 (P<0.001; Table 1).

Table 1. Socio-demographic and lifestyle characteristics of subjects (N=4984)

	Island Vis (N=1027)	Island Korčula (N=2945)	Split (N=1012)	*P*
Gender; n (%)				0.020
Women	600 (58.4)	1863 (63.3)	618 (61.1)	
Men	427 (41.6)	1082 (36.7)	394 (38.9)	
Age; median (IQR)	56.0 (24.0)	55.0 (23.0)	52.2 (21.0)	<0.001
Education (years of schooling); median (IQR)	11.0 (4.0)	12.0 (3.0)	12.0 (4.0)	<0.001
Physical activity; n (%)				<0.001
Light	266 (26.0)	592 (20.7)	360 (35.7)	
Moderate	589 (57.6)	1989 (69.4)	611 (60.6)	
Intensive	168 (16.4)	284 (9.9)	37 (3.7)	
Alcohol consumption; n (%)				<0.001
None	423 (41.3)	989 (35.1)	401 (39.7)	
Moderate	444 (43.4)	1284 (45.5)	478 (47.3)	
Excessive	157 (15.3)	548 (19.4)	132 (13.1)	
Smoking; n (%)				<0.001
Yes	428 (41.8)	1442 (49.9)	465 (46.1)	
Ex-smokers	291 (28.4)	801 (27.7)	266 (26.4)	
Never smoked	306 (29.9)	644 (22.3)	277 (27.5)	
Mediterranean diet compliance (MDSS); n (%)	319 (31.1)	806 (27.4)	307 (30.3)	0.036
BMI (kg/m^2); median (IQR)	27.1 (6.1)	24.7 (5.9)	26.6 (5.6)	<0.001

IQR – interquartile range, MDSS – Mediterranean Diet Serving Score; BMI – Body Mass Index

Figure 1 describes fish consumption frequency in three sub-samples according to the place of residence, separately for men and women. The weekly consumption of fish was highest among men from Vis (64.7%). This number was lowest among men from Split, with 22.6% men who reported eating fish weekly. Similar finding was in women; women from the Island of Vis ate fish most often (57.4% did so weekly), whereas the women from Split had the lowest weekly fish consumption (25%). Both male and female examinees from Split ranked highest in reporting to eat fish rarely or never (19.3% in men; 16.2% in women) (Figure 1).

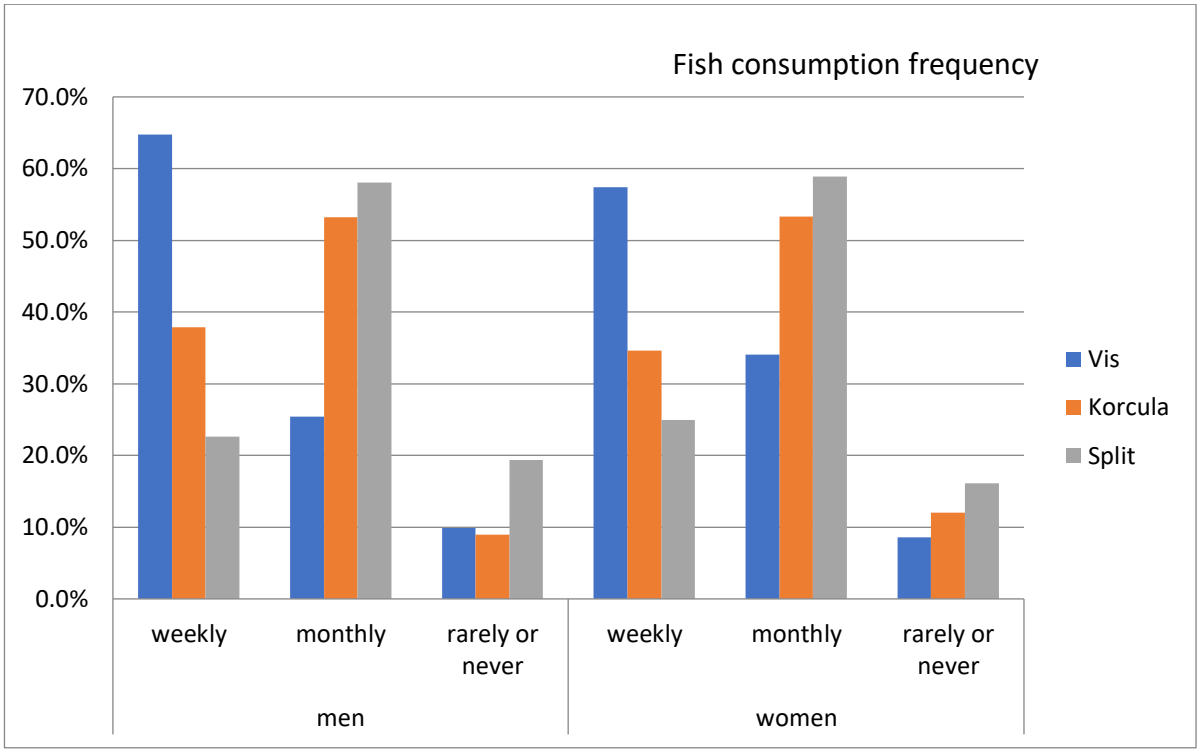

Figure 1. Fish consumption frequency according to the place of residence and gender

In Figure 2 we show white meat consumption frequency in the three different populations, comparing men and women. The highest proportion of weekly white meat consumption was found in women from Split (67.3%), followed with women from Vis (65.4%) and women from Korčula (60.2%). Men from Korčula had the lowest proportion of weekly white meat consumption (51.5%). 53.2% of men from Split and 53.9% from Vis reported to eat white meat weekly. The number of people claiming to eat white meat rarely or never was highest among the population of Vis (13.4% of men, 9.6% of women) (Figure 2).

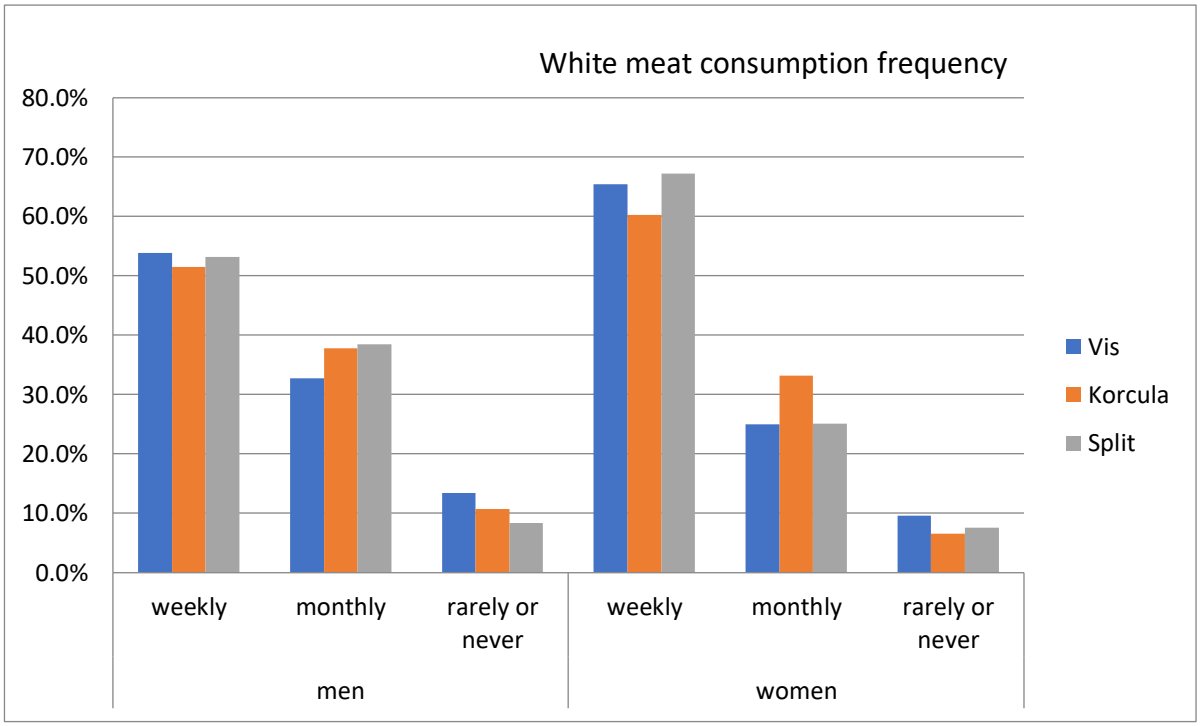

Figure 2. White meat consumption frequency according to the place of residence and gender

Figure 3 displays red meat consumption frequency (combined both pork and beef) and compares men and women from Vis, Korčula and Split. Very few men from Vis reported eating both types of red meat per week (4%), while this number was higher in men form Korčula (10.2%) and highest among male Split residents (13.3%). We found the largest proportion of consumption of one type of red meat per week on the Island of Vis, with 46.5% of men and 43.7% of women. Among the examinees from Split, we found 36.2% of men and 41.5% of women who consumed one type of red meat weekly. In this category, the numbers were lowest on Korčula (28% of men, 24% of women). On Vis we found the highest proportion of participants who never or rarely consumed red meat (males: 15.8%, females: 18.5%) (Figure 3).

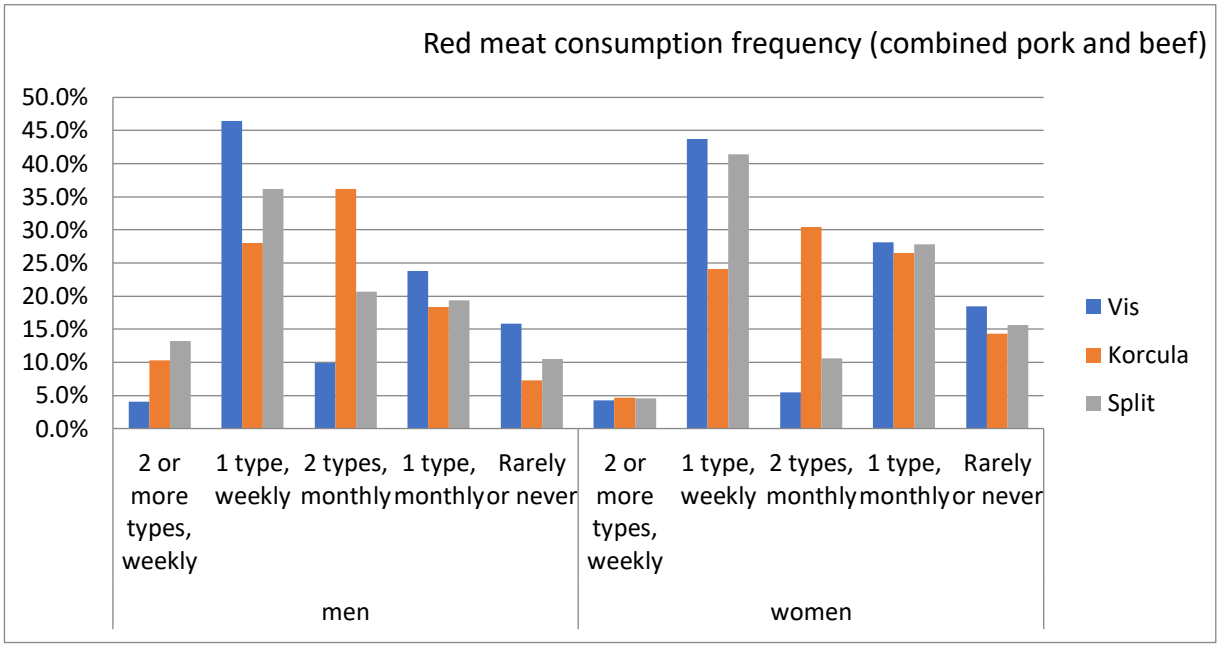

Figure 3. Red meat consumption frequency (combined both pork and beef) according to the place of residence and gender

In Figure 4 we break down the red meat consumption and specifically investigate pork consumption frequency in Split and on the Islands Korčula and Vis. Almost one fifth of men from Korčula ate pork every week (19.7%), in Split it was 17.5% of men and on Vis this percentage was the lowest (6.2%). On a monthly basis, the distribution among men was the same, though the percentages were higher (19.7% on Vis, 34.3% in Split and 50.5% on Korčula). Women from Korčula had the highest percentage of weekly pork consumption (10.4%), while most women reporting that they rarely or never ate pork came from Vis (81.9%) (Figure 4).

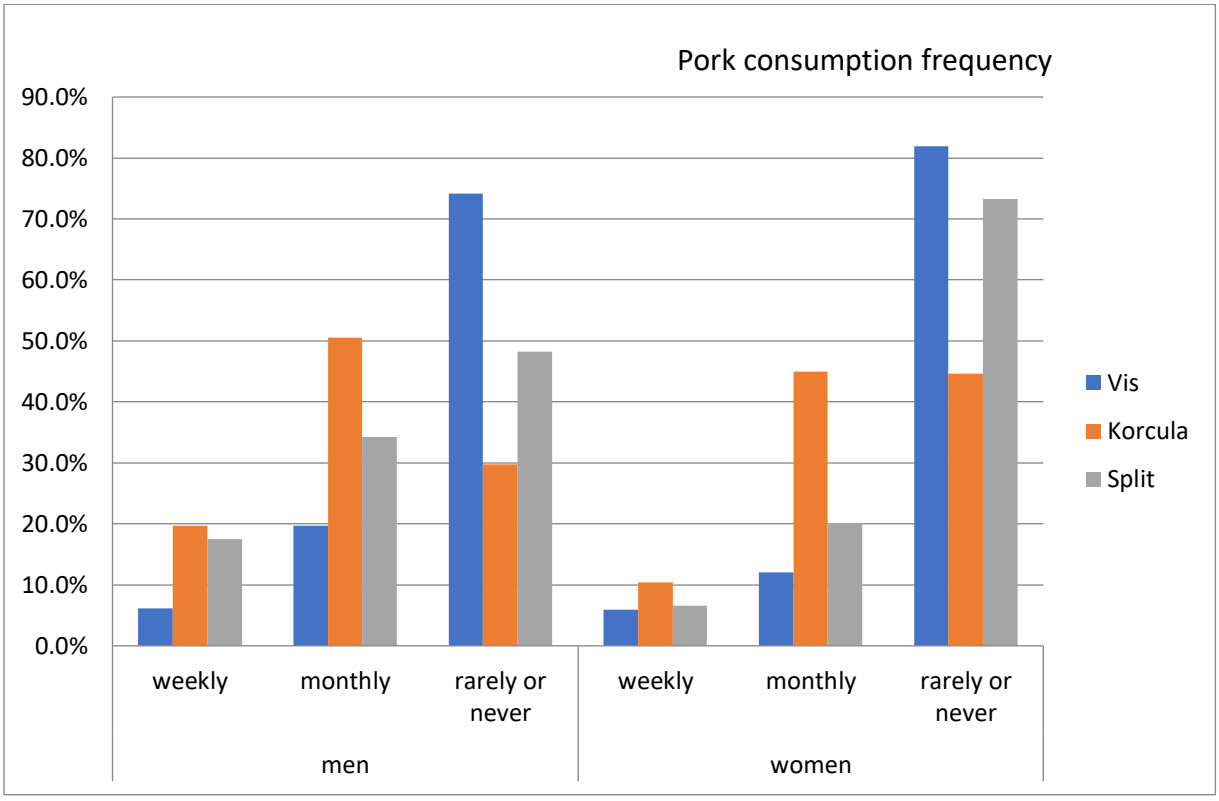

Figure 4. Pork consumption frequency according to the place of residence and gender

Figure 5 further breaks down red meat consumption patterns looking at beef consumption frequency among the studied populations, separately for men and women. Within examinees form the Island of Vis 48.2% of men and 45.8% of women ate beef weekly. In Split 45.3% of men and 44.0% of women reported to eat beef every week. This percentage was lowest on Korčula, with 28.7% of men and 22.7% of women eating beef weekly. Among the population of Korčula more than half of men (58.7%) and women (55.5%) consumed beef on monthly basis. 18.1% of men from Vis, and 12.5% of men from Korčula and Split stated that they never or rarely consumed beef. These numbers were slightly higher among women, with 18.7% of women from Split, 21.5% of women from Vis and 21.8% of women from Korčula claimed that they rarely or never ate beef (Figure 5).

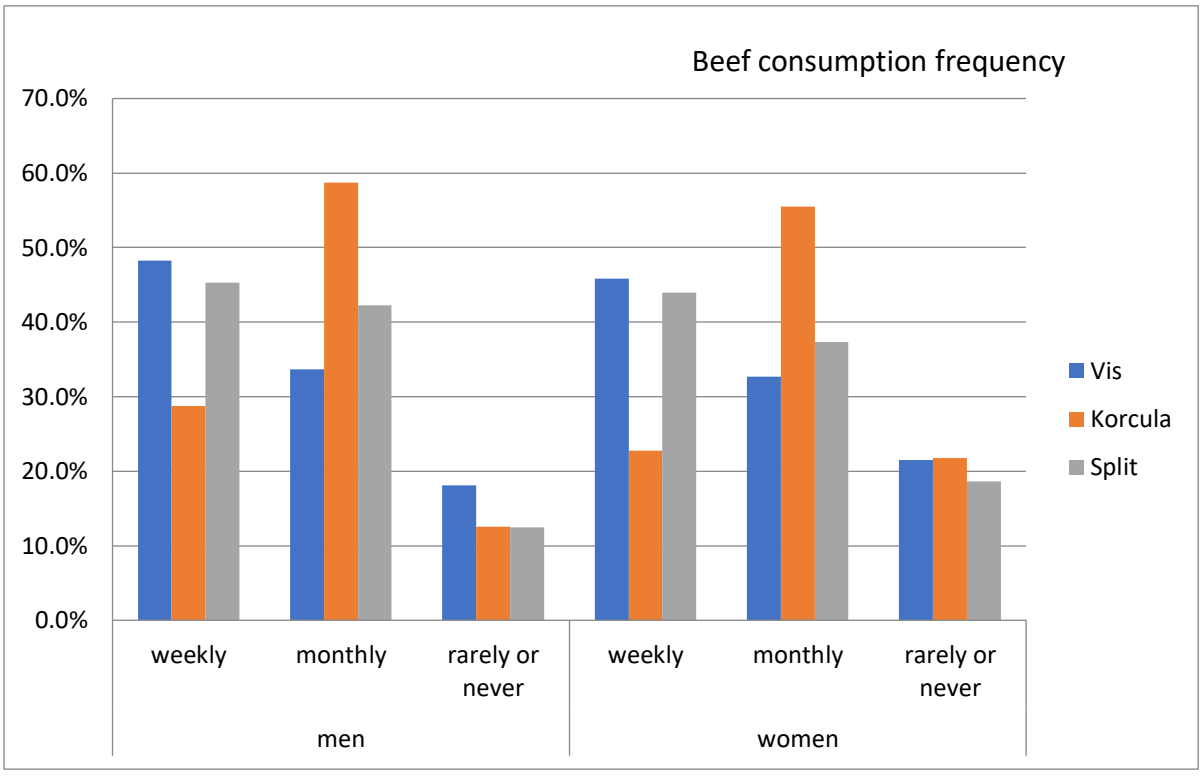

Figure 5. Beef consumption frequency according to the place of residence and gender

In Figure 6 we show processed meat consumption frequency combining bacon, sausages, salami, and processed fish. Split had the highest percentage of men eating one type of processed meat weekly (42.4%); among women from Split this number was lower (26.3%). Among men from Vis and Korčula more than a third of participants claimed to eat one type of processed meat per week (Vis: 33.9%; Korčula: 37.0%). In Split almost half of women reported that they rarely or never ate processed meat (45.9%). The number of examinees who ate two types of processed meat monthly was under 5% in all populations except on Korčula, where 16.3% of men and 12.7% of women claimed to consume two types of processed meat on a monthly basis (Figure 6).

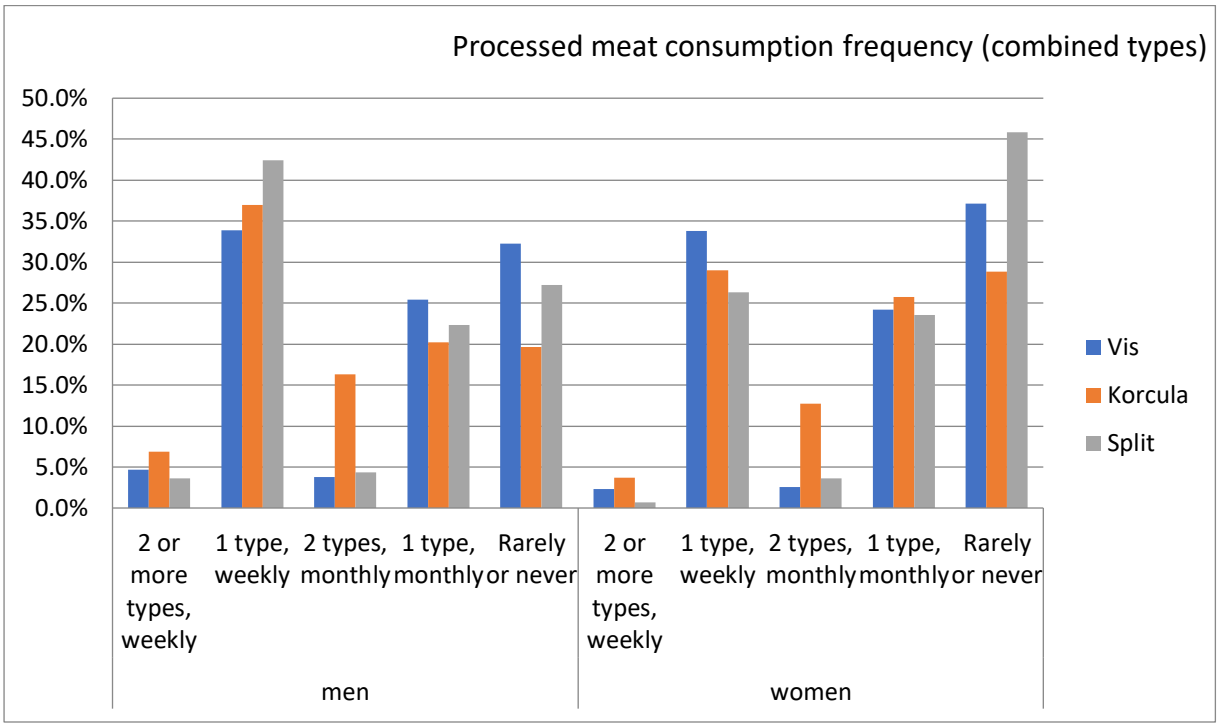

Figure 6. Processed meat consumption frequency (combined types) according to the place of residence and gender

In Figure 7 we show the consumption frequency of bacon in the three studied populations and according to gender. On Korčula we found the highest proportion of examinees who claimed to eat bacon weekly (11.7% of men; 6.6% of women) and monthly (36.7% of men; 27.8% of women). Almost 90% of women both from Vis and Split rarely or never ate bacon (Vis: 87.4%; Split 88.8%). This number was notably lower among the female population of Korčula (65.5%). Among males from Vis and Split around 80% (Vis: 81.0%; Split: 80.4%) rarely or never ate bacon, while this was the case for 51.6% of men from Korčula.

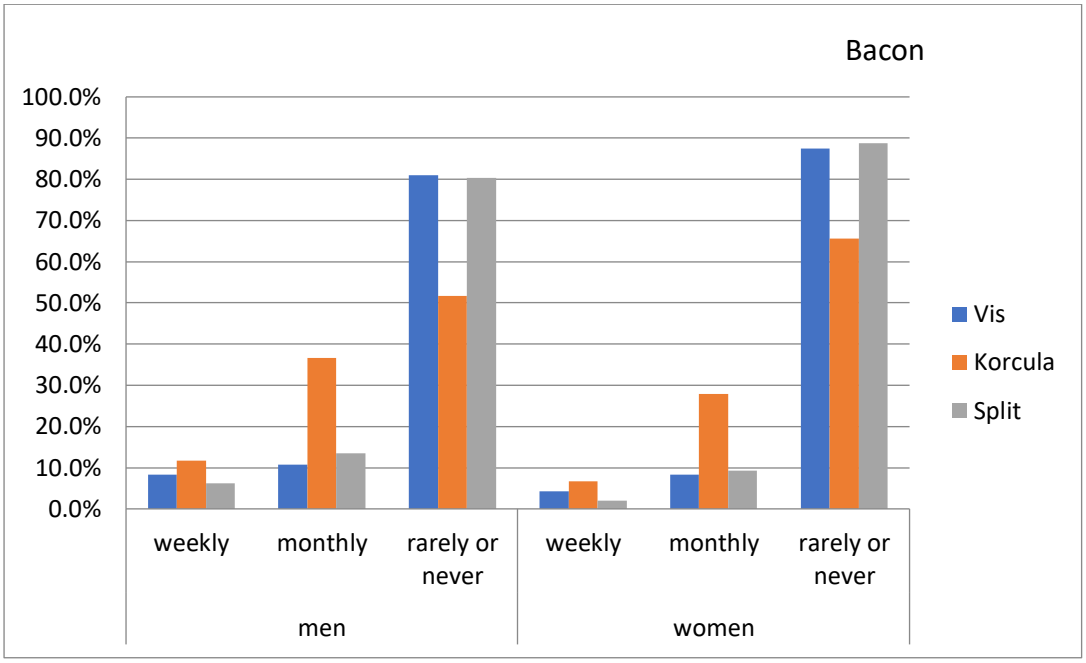

Figure 7. Bacon consumption frequency according to the place of residence and gender

In Figure 8 we show the consumption frequency of sausages in the three studied populations comparing male and female patterns. 10.2% of men from Vis, 9.6% of men from Korčula and 6.2% of men from Split reported that they ate sausages weekly. Among women, these numbers were under 10% in all three populations (9.7% on Vis, 6.8% on Korčula and 3.1% in Split). The highest proportion of people eating sausages every month were found on Korčula (42.2% of men and 33.2% of women). 69.0% of men and 66.3% of women from the Island Vis rarely or never consumed sausages. On Korčula, almost half of men (48.1%) and more than half of women (59.9%) rarely or never ate sausages. In Split the difference between the genders was the highest: 64.9% of men and 80.3% of women reported that they rarely or never consumed sausages (Figure 8).

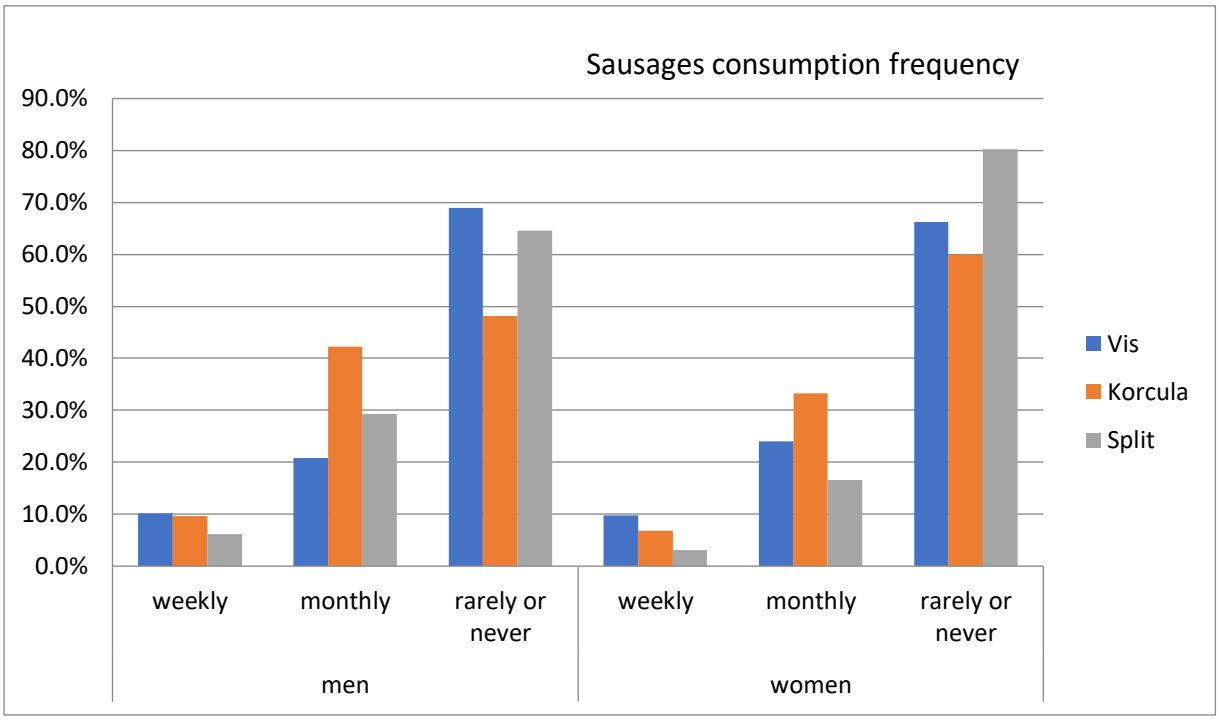

Figure 8. Sausages consumption frequency according to the place of residence and gender

Figure 9 demonstrates salami consumption frequency comparing examinees from Vis, Korčula and Split and subdividing them into men and women. The percentage of men who reported to eat salami weekly was highest among the population of Split (41.1%). On the Island of Vis, almost half of men (49.1%) said that they rarely or never ate salami. In comparison to that, 38.9% of men from Korčula and 37.0% of men from Split claimed to consume salami never or rarely. The percentage of examinees who rarely or never ate salami was highest among females in all three populations (Vis: 56.9%, Split: 56.5%, Korčula: 49.8%) (Figure 9).

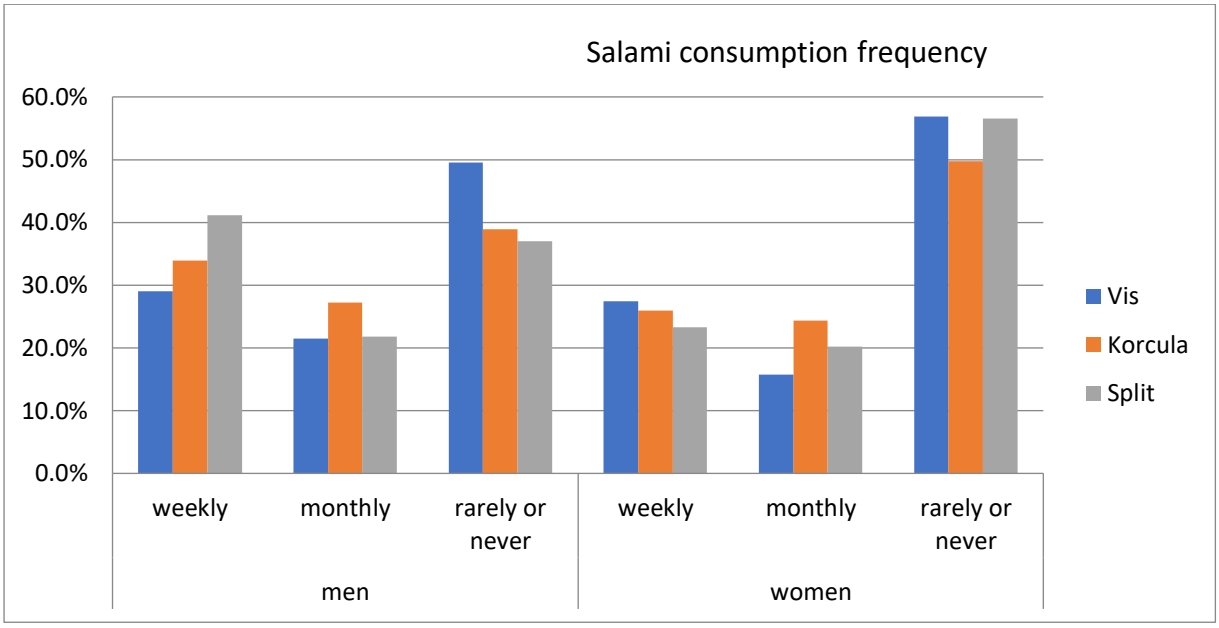

Figure 9. Salami consumption frequency according to the place of residence and gender

Figure 10 displays processed fish consumption frequency and compares our three studied populations Vis, Korčula and Split. It further shows patterns for men and women. Weekly processed fish consumption was under 5% in all populations, except among men from Vis (5.2%). The number of examinees consuming processed fish on a monthly basis was found to be higher, with the highest numbers found on Korčula (25.3% of men, 19.1% of women). In Split, over 90% of both men (90.6%) and women (92.6%) claimed to rarely or never eat processed fish. Among examinees from Vis, 78.9% of men and 84.5% of women rarely or never consumed processed fish. On Korčula, 70.7% of men and 78.0% of women reported that they rarely or never ate processed fish (Figure 10).

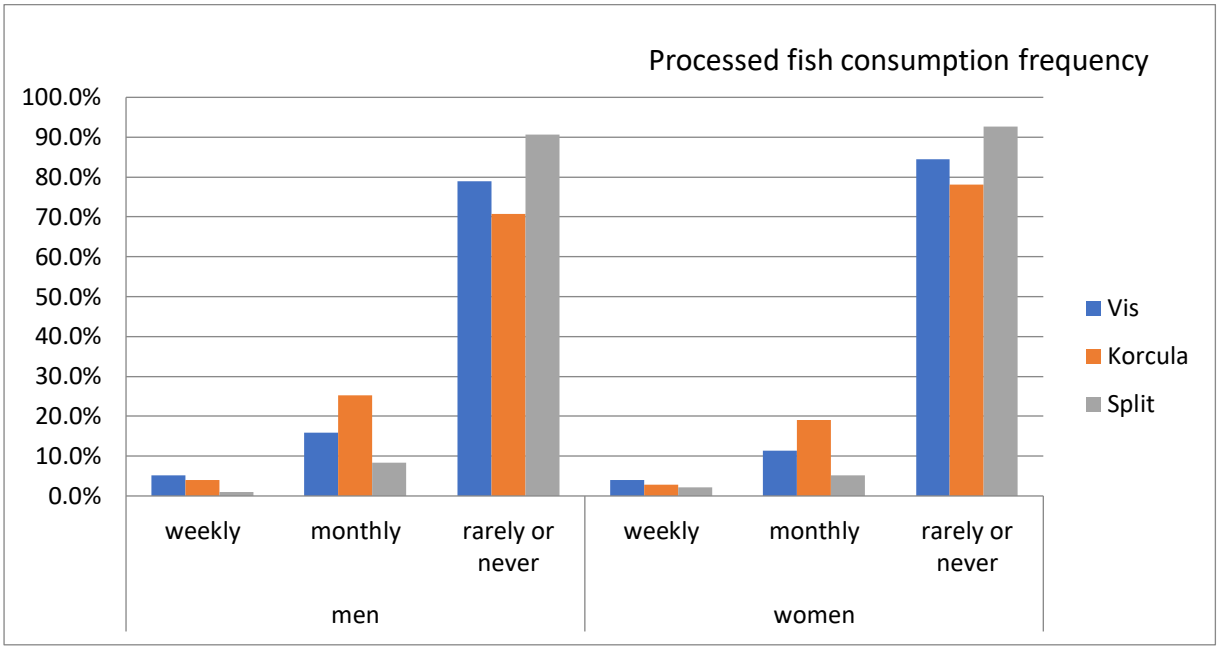

Figure 10. Processed fish consumption frequency according to the place of residence and gender

Table 2 shows the meat consumption frequency according to the age group. Among the examinees in the youngest age group (18–34.9 years) we found the least percentage of people who reported to eat fish every week (23.9%). More than one fifth of examinees in this age group rarely or never consumed fish (20.7 %) (P=0.004; Table 2). On the other hand, participants older than 65 years had the highest percentage of weekly fish consumption (53.3%). Looking at white meat consumption, we found that the least percentage of weekly white meat consumption (56.8%) was reported by the examinees in the youngest age group, but they instead reported the highest proportion of monthly white meat consumption (36.1%)

(*P*<0.001). Weekly consumption of both types of red meat (pork and beef) was highest among the youngest population (8.9%), and lowest among oldest examinees (4.4 %; Table 2). 6.7% of the participants in the age group of 35–64.9 years claimed to eat two types of red meat weekly (*P*<0.001; Table 2). Almost half of examinees who were 18–34.9 years old reported to consume one type of processed meat weekly (49.1%), while this percentage was lower in the age group of 35–64.9 years (34.5%), and the lowest among examinees ≥65 years of age (18.8%) (*P*<0.001; Table 2). In the oldest age group, we found the highest proportion of participants who reported that they rarely or never ate processed meat (43%). The lowest number of people who never or rarely consumed processed meat were found among the age group 18–34.9 (15.1%). Almost half of examinees in the age group 18–34.9 reported to eat one type of processed meat weekly (49.1%) (*P*<0.001; Table 2).

Table 2. Meat consumption frequency according to age group

	18 - 34.9 years old (N=709)	35 - 64.9 years old (N=2931)	≥65 years old (N=1344)	*P*
Fish; n (%)				0.004
Weekly	166 (23.9)	1015 (35.4)	688 (53.5)	
Monthly	386 (55.5)	1517 (53.0)	499 (38.8)	
Rarely or never	144 (20.7)	332 (11.6)	99 (7.7)	
White meat; n (%)				<0.001
Weekly	395 (56.8)	1677 (58.6)	771 (60.3)	
Monthly	251 (36.1)	954 (33.3)	367 (28.7)	
rarely or never	50 (7.2)	230 (8.0)	140 (11.0)	
Red meat (combined pork and beef); n (%)				<0.001
2 types, weekly	62 (8.9)	190 (6.7)	56 (4.4)	
1 type, weekly	198 (28.5)	939 (33.1)	422 (33.4)	
2 types, monthly	249 (35.8)	671 (23.7)	203 (16.0)	
1 type, monthly	108 (15.5)	705 (24.9)	353 (27.9)	
Rarely or never	78 (11.2)	330 (11.6)	231 (18.3)	
Processed meat; n (%)				<0.001
2 or more types, weekly	39 (5.6)	113 (4.0)	35 (2.7)	
1 type, weekly	342 (49.1)	983 (34.5)	240 (18.8)	
2 or more types, monthly	69 (9.9)	291 (10.2)	103 (8.1)	
1 type, monthly	141 (20.3)	656 (23.0)	351 (27.4)	
Rarely or never	105 (15.1)	803 (28.2)	550 (43.0)	

In Table 3 we show meat consumption frequency according to the BMI categories. There was no statistically significant difference in white meat (*P*=0.685), red meat (*P*=0.114) and processed meat (*P*=0.306) intake between BMI category groups. However, we found a statistically significant difference in the fish consumption patterns (*P*=0.004). Examinees with

normal BMI (<25 kg/m^2) reported the lowest percentage of weekly fish consumption (35.8%), while 40.5% of overweight (BMI 25–29.9 kg/m^2) and 40.5% of obese (BMI≥30 kg/m^2) participants reported they eat fish on a weekly basis. Furthermore, among the examinees with the normal BMI, 13.4% claimed they never or rarely eat fish, compared to 11.2% of overweight examinees and 9.9% of obese examinees (*P*=0.004; Table 3). More than half of examinees with normal BMI were found to eat fish monthly (50.8 %); this number was slightly lower among overweight examinees (48.3%).

Table 3. Meat consumption frequency according to the BMI categories

	BMI <25 kg/m^2 (N=2115)	BMI 25-29.9 kg/m^2 (N=1859)	BMI ≥30 kg/m^2 (N=869)	*P*
Fish; n (%)				0.004
Weekly	742 (35.8)	736 (40.5)	349 (40.5)	
Monthly	1054 (50.8)	877 (48.3)	428 (49.7)	
Rarely or never	277 (13.4)	204 (11.2)	85 (9.9)	
White meat; n (%)				0.685
Weekly	1231 (59.4)	1057 (58.4)	501 (58.4)	
Monthly	670 (32.3)	601 (33.2)	273 (31.8)	
Rarely or never	172 (8.3)	153 (8.4)	84 (9.8)	
Red meat (combined pork and beef); n (%)				0.114
2 types, weekly	118 (5.7)	120 (6.7)	63 (7.4)	
1 type, weekly	639 (31.1)	594 (33.1)	301 (35.4)	
2 types, monthly	505 (24.6)	399 (22.2)	188 (22.1)	
1 type, monthly	517 (25.1)	445 (24.8)	183 (21.5)	
Rarely or never	277 (13.5)	239 (13.3)	116 (13.6)	
Processed meat; n (%)				0.306
2 or more types, weekly	84 (4.1)	64 (3.5)	36 (4.2)	
1 type, weekly	702 (34.0)	573 (31.7)	252 (29.5)	
2 or more types, monthly	181 (8.8)	181 (10.0)	86 (10.1)	
1 type, monthly	470 (22.7)	444 (24.5)	218 (25.6)	
Rarely or never	629 (30.4)	547 (30.2)	261 (30.6)	

Table 4 shows characteristics associated with either overweight or obesity in 4523 subjects from Dalmatia. Women had reduced chances to be overweight or obese compared to men (odds ratio [OR] 0.356, 95% confidence interval [CI] 0.304–0.418, $P<0.001$; Table 4). Subjects from the Island of Korčula were less likely to be overweight or obese compared to subjects from Split (OR 0.332, 95% CI 0.277–0.397, $P<0.001$; Table 4). Active smokers had smaller probability for being overweight or obese, compared to those who never smoked (OR 0.712, 95% CI 0.605–0.837, $P<0.001$; Table 4), the same as subjects who reported moderate alcohol intake, compared to subjects who did not consume alcohol (OR 0.802, 95% CI 0.692–0.931, $P=0.004$; Table 4).

One of the characteristics that was associated with an increased BMI was age. Compared to the youngest age group (18–34.9 years old), those in the older age groups were more likely to be obese or overweight ($P<0.001$; Table 4). Suffering from one chronic disease was also associated with increased BMI (OR 1.7, 95% CI 1.447–1.997, $P<0.001$; Table 4). This association was even higher if the examinee suffered from two or more chronic illnesses (OR 2.387, 95% CI 1.915–2.976, $P<0.001$; Table 4). Examinees who reported to be non-compliant to the Mediterranean diet had a 24% increased chance to be overweight or obese compared to those being compliant (OR 1.244, 95% CI 1.070–1.447, $P=0.005$; Table 4). Consumption of one or two types of processed meat monthly was also associated with an increased BMI (2 types, monthly: OR 1.554, 95% CI 1.200–2.011, $P=0.001$; Table 4) (1 type, monthly: OR 1.236, 95% CI 1.031–1.482, $P=0.022$; Table 4).

Table 4. Characteristics associated with either overweight or obesity (BMI ≥25 kg/m^2) in 4523 subjects from Dalmatia (logistic regression)

	OR	95% CI	*P*
Women; men are referent group	0.356	0.304 - 0.418	<0.001
Age group; referent group: 18-34.9 years			<0.001
35.0-64.9 years old	2.800	2.282 - 3.436	<0.001
≥65 years old	2.676	2.069 - 3.459	<0.001
Place of residence; Split is referent group			<0.001
Vis	0.940	0.756 - 1.168	0.577
Korčula	0.332	0.277 - 0.397	<0.001
Education (years of schooling); tertiary is referent group			0.007
Primary (≤8)	1.402	1.133 - 1.734	0.002
Secondary (9-12)	1.130	0.959 - 1.332	0.145
Chronic disease; none is referent group			<0.001
One	1.700	1.447 - 1.997	<0.001
Two or more	2.387	1.915 - 2.976	<0.001
Smoking; never is referent group			<0.001
Ex-smokers	1.181	0.998 - 1.398	0.053
Active smokers	0.712	0.605 - 0.837	<0.001
Alcohol intake; none is referent group			0.008
Moderate	0.802	0.692 - 0.931	0.004
Excessive	0.957	0.769 - 1.192	0.698
Physical activity; intensive is referent			0.098
Light	1.068	0.829 - 1.378	0.610
Moderate	0.903	0.721 - 1.131	0.374
Mediterranean diet non-compliance (MDSS); Yes is referent group	1.244	1.070 - 1.447	0.005
White meat; rarely or never is referent			0.753
Weekly	1.078	0.846 - 1.373	0.544
Monthly	1.103	0.855 - 1.422	0.452
Fish; rarely or never is referent group			0.236
Weekly	1.182	0.942 - 1.483	0.148
Monthly	1.202	0.970 - 1.489	0.092
Red meat; rarely or never is referent			0.024
2 types, weekly	1.227	0.883 - 1.705	0.222
1 type, weekly	0.955	0.769 - 1.186	0.679
2 types, monthly	1.227	0.966 - 1.558	0.093
1 type, monthly	0.917	0.734 - 1.146	0.447
Processed meat; rarely or never is referent			0.005
2 or more types, weekly	0.978	0.678 - 1.411	0.906
1 type, weekly	1.075	0.902 - 1.282	0.419
2 types, monthly	1.554	1.200 - 2.011	0.001
1 type, monthly	1.236	1.031 - 1.482	0.022

In Table 5 we investigated which characteristics were associated with obesity in our sample. Examinees who ate fish monthly (compared to rarely or never) were 33% more likely to be obese (OR 1.334, 95% CI 1.011–1.760, *P*=0.042; Table 5). Red meat consumption was also associated with being obesity status, where those examinees who consumed both pork and beef monthly were 40% more likely to be obese (OR 1.398, 95% CI 1.039–1.880, *P*=0.027, Table 5), while those who consumed both types of red meat weekly had marginally insignificant result (OR 1.446, 95% CI 0.982-2.131, *P*=0.062; Table 5). Furthermore, subjects who reported to consume two types of processed meat monthly were more likely to be obese than those who reported that they rarely or never consumed processed meat (OR 1.536, 95% CI 1.126–2.096, *P*=0.007, Table 5).

Table 5. Characteristics associated with obesity (BMI ≥30 kg/m^2) in 4523 subjects from Dalmatia (logistic regression)

	OR	95% CI	*P*
Women; men are referent group	0.846	0.700 - 1.024	0.086
Age group; 18-34.9 years is referent group			<0.001
35.0-64.9 years old	2.149	1.555 - 2.970	<0.001
≥65 years old	1.718	1.184 - 2.493	0.004
Place of residence; Split is referent group			<0.001
Vis	1.055	0.830 - 1.341	0.663
Korčula	0.425	0.342 - 0.528	<0.001
Education (years of schooling); tertiary is referent group			0.020
Primary (≤8)	1.441	1.116 - 1.861	0.005
Secondary (9-12)	1.201	0.973 - 1.482	0.088
Chronic disease; none is referent group			<0.001
One	2.234	1.849 - 2.699	<0.001
Two or more	2.536	2.003 - 3.211	<0.001
Smoking; never is referent group			<0.001
Ex-smokers	1.223	1.008 - 1.484	0.041
Active smokers	0.774	0.624 - 0.959	0.019
Alcohol intake; none is referent group			0.006
Moderate	0.746	0.620 - 0.898	0.002
Excessive	0.899	0.695 - 1.161	0.413
Physical activity; intensive is referent group			0.048
Light	1.313	0.969 - 1.780	0.079
Moderate	1.053	0.798 - 1.389	0.715
Mediterranean diet non-compliance (MDSS); Yes is referent group	1.289	1.066 - 1.558	0.009

Table 5. Characteristics associated with obesity (BMI ≥30 kg/m^2) in 4523 subjects from Dalmatia, *continued*

	OR	95% CI	*P*
White meat; rarely or never is referent group			0.479
Weekly	0.840	0.632 - 1.117	0.230
Monthly	0.876	0.649 - 1.182	0.386
Fish; rarely or never is referent group			0.113
Weekly	1.220	0.911 - 1.632	0.182
Monthly	1.334	1.011 - 1.760	0.042
Red meat; rarely or never is referent group			0.004
2 types, weekly	1.446	0.982 - 2.131	0.062
1 type, weekly	1.104	0.849 - 1.434	0.461
2 types, monthly	1.398	1.039 - 1.880	0.027
1 type, monthly	0.886	0.672 - 1.169	0.392
Processed meat; rarely or never is referent group			0.051
2 or more types, weekly	1.332	0.861 - 2.059	0.197
1 type, weekly	1.059	0.852 - 1.317	0.603
2 types, monthly	1.536	1.126 - 2.096	0.007
1 type, monthly	1.202	0.967 - 1.495	0.097

5. DISCUSSION

According to the results of this study, we found an association between consumption of several types of meat and the BMI, namely fish, red meat and processed meat.

Fish consumption was associated with an increased BMI in both bivariate and multivariate analyses. Among examinees with a BMI<25 kg/m^2, we found the lowest percentage of people who ate fish every week (35.8%), while almost half of both overweight and obese examinees ate fish weekly (40%). In order to exclude confounding factors, we explored the association between other important characteristics and obesity and overweight status in examinees. Age was a major factor that was associated with an increased BMI. The older our examinees were, the higher their BMI was. In addition to that, the oldest subjects more frequently ate fish on the weekly basis (53%, compared to 24% in youngest age group). This makes age a confounding factor in the association between BMI and fish consumption in the studied population. However, logistic regression results indicated that subjects who ate fish monthly, compared to those who ate fish rarely or never, had a 45% increased probability of being obese. Those subjects who ate fish weekly had no such association, and the same result was recorded for the association between fish consumption and BMI≥25 kg/m^2. A possible explanation for this finding is a cross-sectional nature of this study, where people who became obese may have started consuming fish less frequently, monthly instead of weekly.

A study published in 2013 found no association between fish consumption and body-weight gain (36). Numerous studies suggested that intake of fish can lead to several health benefits. A study conducted in 2012 found evidence that consumption of fish and seafood could lead to a reduction of cardiovascular disease and to a healthier life in general (37). Another study pointed out that consumption of fish with its high omega 3 fatty acid content can both lead to better cardiac health (e.g. by improving cardiac function or lowering blood pressure) and to beneficial outcomes for other organs (38). In order to investigate this further, it would be necessary to perform an analysis of a direct (and causal) association between fish consumption and development of chronic diseases, within a cohort study design or an experimental design. Such a study was performed, within the PREDIMED trial, and it was found that people who consumed recommended amount of marine ω-3 fatty acids (≥500 mg/day) had a 39% reduced risk for fatal cardiovascular disease and 46% reduced risk for fatal coronary heart disease (39).

Our study found that consumption of one or two types of processed meat monthly was associated with an increased BMI. As many as 49% of younger examinees (18–34.9 years old)

reported to eat one type of processed meat per week and 20% of them reported eating one type per month, while 19% of subjects older than 65 years reported weekly and 27% reported monthly intake of one type of processed meat. Inspecting weekly consumption of processed meat, we found that this was more prevalent among the younger, and therefore thinner population, while more frequent abstinence from processed meat was recorded in the oldest subjects (43%, compared to 15% in youngest subjects). Still, in regression analysis we have identified the association between monthly intake of processed meat and both BMI≥25 kg/m^2 and BMI≥30 kg/m^2. We also found a marginally insignificant association for weekly red meat consumption of both pork and beef with the BMI≥30 kg/m^2 (P=0.062). This is in line with previous results. For instance, a meta-analysis, which included 18 studies and 113,477 subjects, indicated that higher consumption of red and processed meats was associated with a 37% increased odds of being obese (OR 1.37; 95% CI 1.14-1.64) (40).

Besides age effect on lifestyle habits, gender also plays a significant role. Many studies have found more prevalent health consciousness among female populations (41). For example, the study on dietary patterns found that especially older women (>60 years) tend to develop a pronounced health consciousness and are more inclined to eat vegetables and healthy foods than men (42). Our study results confirmed these findings, and we showed that women had decreased probability of overweight and obesity compared to men. Our female subjects in all three populations claimed to eat white meat weekly more frequently, compared to their male counterparts. Over 60% of females from Vis, Korčula and Split ate white meat weekly; this number was under 55% among males. The study conducted in 2015 in Italy suggests that white meat consumption may be helpful in reducing both incidence of overweight and obesity and of chronic illnesses like diabetes mellitus type 2 and cardiovascular diseases (43). However, this was only concluded for a diet rich in vegetables that was combined with white meat. More studies need to be conducted on white meat consumption in order to draw any definite conclusions.

Another difference that we found in dietary patterns between males and females was the frequency of processed meat consumption. The proportion of men, who claimed to eat processed meat on a weekly basis, was higher in all three populations compared to that of women. Considering that males in our sample tended to have a higher BMI, these findings are in concordance with several studies conducted over the years confirming a direct association between processed meat intake and risk of obesity and increased BMI (40) (44).

We further found a statistically significant association between non-adherence to the Mediterranean Diet and being overweight and obese. This is similar finding to other studies, which found an association between a decrease in obesity and adherence to Mediterranean diet (45).

Examinees from Vis had the highest BMI and the highest adherence to the Mediterranean Diet. Age seems to be a confounding factor behind this result too. Socio-demographic and lifestyle characteristics of our subjects show that examinees from Vis were not only the ones with the highest BMI but also the oldest. One might assume that eating more fish is not the factor that leads to an increased BMI but simply the older age and the chronic diseases that go hand in hand with aging. One cohort study conducted in Norway investigated BMI changes in over 1000 men and women over an 11-year period (39). This study showed an increase in the BMI of the examinees over the years in both genders, independent of socioeconomic status (46).

In order to uncover why the population of Korčula was found to have the lowest BMI even though they were the least compliant to the Mediterranean diet, we need to look closer at their socio-demographic and lifestyle characteristics. Among examinees from Korčula we found the highest proportion of women compared to Vis and Split. Furthermore, they had the highest proportion of subjects claiming to exercise moderately. Concerning alcohol consumption, they were found to be the population with least non-drinkers and most excessive alcohol drinkers. On Korčula almost half of examinees were active smokers (in Spit and on Vis these proportions were lower). Our results indicate that active smokers were less likely to be overweight or obese than people who have never smoked or people who stopped smoking. Other studies also suggest an association between smoking and BMI. For example, a cross-sectional study conducted in over 20,000 people found that smoking cessation was associated with a higher BMI, compared to those who did not stop smoking (47).

Additional characteristics associated with increased BMI were lower education and the presence of chronic diseases, while subjects who moderately consumed alcohol were less likely to have increased BMI.

The limitations of this study include the use of cross-sectional design, in which we cannot distinguish temporal component of causality. The strength of this study was the large

sample size of almost 5,000 subjects who were recruited from the general population, and not from clinics among which we might expect a higher percentage of obese or overweight subjects.

6. CONCLUSION

1. We found an association between processed meat, red meat and fish consumption and an increased BMI in the population of Dalmatia.

2. There was a statistically significant association between non-adherence to the Mediterranean diet and a higher BMI.

3. Additional characteristics associated with increased BMI were male gender, older age, lower education, presence of chronic diseases, and ex-smoker status, while moderate alcohol intake and active smoking were associated with a reduced probability for higher BMI.

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8. SUMMARY

Title: Meat consumption patterns and the body mass index in the population of Dalmatia

Objectives: To investigate the patterns of meat consumption and to assess the association between different meat consumption patterns and BMI in a large population-based sample.

Materials and Methods: Examinees from the city of Split (N=1012), the island of Vis (N=1027) and the island of Korčula (N=2945) were included in this cross-sectional study. Anthropometric index included in the analyses was the BMI. Data were collected using a self-administered questionnaire, including age, gender, education, medical history, physical activity, consumption of alcohol, smoking habits, and dietary habits. Dietary pattern was assessed using a food frequency questionnaire including typical food items consumed in Dalmatia. Mediterranean diet was assessed based on the responses from the food frequency questionnaire and a Mediterranean Diet Serving Score was calculated for each subject. Meat consumption was assessed separately for fish, white meat, red meat and processed meat. The statistical analysis was performed using a Chi-square test, Kruskal-Wallis test and multivariate binary logistic regression.

Results: There was a positive association between fish consumption and age (P=0.004), as well as with the BMI (P=0.004). Results indicated a reduced probability for overweight or obesity in women (OR 0.356, 95% CI 0.304–0.418, P<0.001), subjects living on the Island of Korčula (OR 0.332, 95% CI 0.277–0.397, P<0.001), active smokers (OR 0.712, 95% CI 0.605–0.837, P<0.001) and moderate alcohol consumers (OR 0.802, 95% CI 0.692–0.931, P=0.004). There was a positive association between increased BMI and age (P<0.001), as well as with the presence of one or more chronic diseases (P<0.001) and non-compliance to the Mediterranean diet (OR 1.244, 95% CI 1.070–1.447, P=0.005). Consumption of one or two types of processed meat monthly was also associated with a BMI≥25 kgm^2 (2 types, monthly: OR 1.554, 95% CI 1.200–2.011, P=0.001; 1 type, monthly: OR 1.236, 95% CI 1.031–1.482, P=0.022). Regarding obesity, there was a positive association with monthly fish consumption (OR 1.334, 95% CI 1.011–1.760, P=0.042), monthly red meat consumption (OR 1.398, 95% CI 1.039–1.880, P=0.027) and monthly processed meat consumption (OR 1.536, 95% CI 1.126–2.096, P=0.007).

Conclusion: We found a positive association between processed meat, red meat and fish consumption and an increased BMI in the population of Dalmatia.

9. CROATIAN SUMMARY

Naslov: Obrasci potrošnje mesa i indeks tjelesne mase u populaciji Dalmacije

Ciljevi: Istražiti obrasce konzumacije mesa i procijeniti povezanost između konzumacije različitih vrsta mesa i indeksa tjelesne mase (ITM) u velikom uzorku iz opće populacije.

Materijali i metode: Ispitanici iz grada Splita (N=1012), s otoka Visa (N=1027) i s otoka Korčule (N=2945) bili su uključeni u ovo presječno istraživanje. Antropometrijski indeks uključen u analizu bio je ITM. Podaci su prikupljeni korištenjem upitnika o dobi, spolu, obrazovanju, povijesti bolesti, tjelesnoj aktivnosti, konzumiranju alkohola, navikama pušenja i prehrambenim navikama. Prehrambene navike procijenjene su pomoću upitnika o učestalosti konzumacije pojedinih namirnica koje se tipično koriste u Dalmaciji. Mediteranska prehrana je procijenjena na temelju odgovora na taj upitnik i izračunat je indeks mediteranske prehrane za svakog ispitanika (engl. *Mediterranean Diet Serving Score*). Potrošnja mesa je procijenjena odvojeno za ribu, bijelo meso, crveno meso i prerađeno meso. Statistička analiza provedena je pomoću hi-kvadrat testa, Kruskal-Wallisovog testa i multivarijatne logističke regresije.

Rezultati: Zabilježena je pozitivna povezanost između konzumacije ribe i dobi (P=0,004), kao i ITM-a (P=0,004). Rezultati ukazuju na smanjenu vjerojatnost za prekomjernu tjelesnu masu ili pretilost kod žena (OR 0,356; 95% CI 0,304-0,418; P<0,001), ispitanika koji žive na otoku Korčuli (OR 0,332; 95% CI 0,277-0,397; P<0,001), onih koji puše (OR 0,712; 95% CI 0,605-0,837; P<0,001) i umjereno konzumiraju alkohol (OR 0,802;95% CI 0,692-0,931; P=0,004). Postojala je i pozitivna povezanost između povećanog ITM-a i dobi (P<0,001), kao i prisutnosti jedne ili više kroničnih bolesti (P<0,001) i nepridržavanje mediteranske prehrane (OR 1,244; 95% CI 1,070-1,447; P=0,005). Potrošnja jedne ili dvije vrste prerađenog mesa na mjesečnoj razini je također bila povezana s ITM≥25 kg/m^2 (2 vrste prerađenog mesa konzumirane mjesečno: OR 1,554; 95% CI 1,200-2,011; P=0,001; 1 vrsta prerađenog mesa mjesečno: OR 1,236; 95% CI 1,031-1,482; P=0,022). Zabilježena je i pozitivna povezanost između pretilosti i mjesečne potrošnje ribe (OR 1,334; 95% CI 1,011-1,760; P=0,042), mjesečne potrošnje crvenog mesa (OR 1,398; 95% CI 1,039-1,880; P=0,027), kao i mjesečne potrošnje prerađenog mesa (OR 1,536; 95% CI 1,126-2,096; P=0,007).

Zaključak: Pronašli smo povezanost između povećanog indeksa tjelesne mase i konzumiranja prerađenog mesa, crvenog mesa i ribe u populaciji Dalmacije.

10. CURRICULUM VITAE

Personal information

Name: Josefin Lundström

Date & place of birth: 23rd of October 1988, Langenhagen, Germany

Nationality: Swedish & German

Address: Dirmingerstraße 4, 66571 Eppelborn, Germany

E-mail: josefin1917@gmx.de

Education

Since October 2012: Medical Studies at the University of Split, School of Medicine

October 2009–September 2012: Historisch orientierte Kulturwissenschaften at University of Saarland, Germany

June 2008: Abitur at Johannes Kepler Gymnasium in Lebach, Germany

Other activities

March 2009-September 2012: Journalist at "Saarländischer Rundfunk" in Saarbrücken, Germany