potravinárstvo®
Slovak Journal of Food Sciences

Potravinarstvo Slovak Journal of Food Sciences
vol. 14, 2020, p. 828-835
https://doi.org/10.5219/1428
Received: 26 June 2020. Accepted: 7 August 2020.
Available online: 28 September 2020 at www.potravinarstvo.com
© 2020 *Potravinarstvo Slovak Journal of Food Sciences*, License: CC BY 3.0
ISSN 1337-0960 (online)

EFFECTS OF MEAT AND PROCESSED MEAT CONSUMPTION ON THE LIPID PROFILE IN THE POPULATION WITH CARDIOVASCULAR DISEASES

Jana Kopčeková, Jana Mrázová, Martina Gažarová, Marta Habánová

ABSTRACT

Meat represents an important source of high-quality dietary protein for a large proportion of the global population. Also, red meat, in particular, significantly contributes to the intake of a wide range of micronutrients, including iron, zinc, selenium, vitamin D, and vitamin B12. Excessive consumption of meat and meat products is often associated with overconsumption of energy and fat, resulting in excess weight, obesity, and an increased risk of chronic diseases, such as cardiovascular disease and type 2 diabetes. This study aims to evaluate the relationship between meat and processed meat consumption frequencies and lipid profile in a group of 800 randomly selected patients hospitalized in the Cardiocentre Nitra. Patients were 20 – 101 years, (men, the average age was 61.13 ±10.47 years). The data necessary for the detection of dietary habits were obtained by a questionnaire method. Statistical comparisons between groups were made utilizing a one-way analysis of variance (one-way ANOVA) followed by Tukey's post hoc test. Our results show, that most respondents consume meat 1 – 2 times per week, while we did not notice a significant effect (p >0.05) of the type of meat on the lipid profile. The highest T-C, LDL-C, and TG values were seen in men who consume pork 3 – 4 times per week. Statistically significant was only the effect of pork meat on total cholesterol and triglycerides (p <0.05). In the consumption of beef and poultry, there was a non-significant effect on biochemical parameters of blood (p >0.05). We recorded a significant effect (p <0.05) of the consumption of frankfurters between consumption 1 – 2 times per week and 3 – 4 times per week. Up to 40.2% of respondents consume salami 3 – 4 times per week, and we recorded a significant effect on LDL levels between consumption 1 – 2 times per week and sometimes (p <0.05). Respondents who consume sausage, headcheese, and others products 1 – 2 times a week have non-significant higher T-C, LDL, TG, and lower HDL compared to less frequent consumption. High consumption of meat, mainly pork and processed meat seems to be associated with higher levels of total cholesterol, LDL cholesterol, and triglycerides.

Keywords: meat; processed meat; cardiovascular disease; lipid profile; dietary habits

INTRODUCTION

The incidence of cardiovascular diseases (CVD) is rapidly increasing worldwide and is currently considered to be the leading cause of death in both developing and developed countries **(Gaziano et al., 2010; Mittal and Singh, 2010)**.

Nutrition is widely recognized as a crucial driver of chronic disease **(Mozaffarian, 2016)**. Dietary habits influence many risk factors for cardiometabolic health, leading to type 2 diabetes, stroke, and heart disease, which are among the leading causes of death globally. Collectively, these risk factors associated with poor quality diet pose substantial health and economic burdens, and studies have shown that dietary factors are one of the main causes of the global burden of disease (measured as disability-adjusted life years) **(GBD 2016 Risk Factors Collaborators, 2016)**.

Most people all over the world eat meat, and meat is central to Western diets **(Pfeiler and Egloff, 2018)**. Consumption of red meats (meats of mammalian origin including beef, pork, and lamb) and processed meats (meats transformed through salting, curing, fermentation, smoking, or other processes to enhance flavor or improve preservation) has been increasing rapidly worldwide **(Godfray et al., 2018; Willett et al., 2019)**.

The epidemiologic literature usually classifies the meat consumed as ”red”, ”white”, and processed meat. Although it does not exist a clear classification of meat and subtypes, in general, all meats obtained from mammals are red meats because they contain more myoglobin than white meat (obtained from chicken or fish) **(Clonan, Roberts and Holdsworth, 2016)**. Processed meat refers to any meat that has been transformed through one or several of the following processes: salting, curing, fermentation, smoking, or other processes to enhance flavor or improve preservation. Most processed meats are made from pork or beef, but may also include other red meats, poultry, offal, or meat by-products such as blood. It is also important to

distinguish between industrial processing and household preparations. As there is a huge variety of processed meat products, it is difficult to sort them into categories **(Santarelli et al., 2008)**.

Although consumption of red meat is valuable for the source of protein, iron, vitamin B12, and other vitamins B in the human diet **(Pereira and Vicente, 2013; Salter, 2018)**, however, evidence from epidemiological studies suggests that higher consumption of red meat and processed meat is associated with a higher risk of developing type 2 diabetes mellitus **(Micha, Michas and Mozaffarian, 2012; Pan et al., 2013)** cardiovascular disease (CVD), **(Micha and Mozaffarian**, **2010)** and certain cancers **(Lippi, Mattiuzzi and Cervellin, 2016; Klurfeld, 2015; Wu et al., 2016)**.

Thus, a recent meta-analysis indicates that higher consumption of red meat and processed meat is associated with an increased risk of total, cardiovascular, and cancer mortality **(Wang et al., 2016)**. Several hypotheses have been formulated to explain the potential association of meat intake (mainly processed meat) with the risk of CVD. For instance, the addition of salt or preservatives to meat for conservation purposes may increase the sodium and nitrate content of meat (processed meats could contain about 400% more sodium and 50% more nitrates per g, although this depends strongly on the type of meat and the methods used) **(Linseisen et al., 2006)**.

Nevertheless, findings from randomized controlled trials assessing the effect of red meat intake on CVD risk factors are inconsistent **(Maki et al., 2012; O'Connor et al., 2017)**. Increased cardiovascular risk related to high consumption of red and processed meat has been linked to their high content of saturated fatty acids (SFA) and cholesterol **(Mozaffarian et al., 2010; Rohrmann and Linseisen, 2016; Clonan, Roberts and Holdsworth, 2016)**. Although the recommendation about dietary cholesterol has become obsolete and the role of saturated fatty acids is currently being reconsidered **(Fernandez, 2012; Lawrence, 2013; Mozaffarian and Ludwig, 2015)**, few consumers are up to date regarding these topics.

Scientific hypothesis

This study aims to evaluate the relationship between meat and processed meat consumption frequencies and lipid profile in a group of randomly selected patients with cardiovascular diseases. We assume that a high-frequency consumption of meat and especially processed meat will be associated with higher levels of total cholesterol (T-C), LDL cholesterol (LDL-C), and triglycerides (TG).

MATERIAL AND METHODOLOGY

We evaluated the relationship between meat and meat products consumption frequencies and lipoproteins concentration in a group of randomly selected patients hospitalized in the Cardiocentre Nitra. This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Cardiocentre Nitra and the Ethics Committee of the Specialized Hospital St. Zoerardus Zobor, protocol number 10.6.2014. Patients were 20 – 101 years, (men, the average age was 61.13 ±10.47 years). Selected respondents have either overcome the *myocardial infarction* or were diagnosed with *angina pectoris* and hospitalized after a procedure so-called catheterization. The data necessary for the detection of dietary habits were obtained by a questionnaire method. The questionnaire was applied individually by a single interviewer. The questionnaire was anonymous, its completion was voluntary with only one response to be circled for each question. The questionnaire contained two parts. The first part included questions concerning the socio-demographic situation of the subjects, body height and weight, physical activity, use of tobacco, and to any changes that took place in the participant's. Based on the data on body height and weight, the Body Mass Index (BMI) was calculated for each of the participants by a standard formula. The second part of the questionnaire concerning the analysis of selected dietary habits: number of the consumed meals, their regularity, snacking between the meals, kinds of the consumed snacks, and eating frequency of selected groups of food products. Data collection was carried out simultaneously with a somatometric and biochemical examination of the respondents ensured by the Cardiocentre Nitra. The lipid profile in blood serum was measured by automatic biochemical analyzer BioMajesty® JCA-BM6010/C (DiaSys Diagnostic System GmbH). The following parameters were evaluated: total cholesterol (T-C), LDL cholesterol (LDL-C), HDL cholesterol (HDL-C) and triacylglycerols (TG) because these parameters are considered to be one of the major risk factors for cardiovascular diseases.

Statistical analysis

Data were expressed in figures as mean ± standard deviation (SD) and statistical comparisons between groups were made utilizing one-way analysis of variance (one-way ANOVA) followed by Tukey's post hoc test. Significance was accepted when $p < 0.05$. The program STATISTICA Cz version 10 (TIBCO Software Inc., Palo Alto, California, USA**)** belonging to the available statistical programs and MS Excel 2007 (Microsoft Corporation, Redmond, Washington, USA) was used.

RESULTS AND DISCUSSION

Table 1 and Table 2 describes the basic and demographic statistical characteristics of the study population.

Meat consumption

A well-balanced diet is an important element for health and wellbeing through the whole life span **(Gille, 2010; Löser, 2014)**. It is still widely acknowledged that lean red meat is an important complete protein source, in addition to contributing to essential micronutrient requirements, particularly iron, zinc, and B vitamins **(Biesalski, 2005; McAfee et al., 2010; Webster-Gandy et al., 2012; Pereira and Vicente, 2013)**.

Most participants consumed meat regularly. Only 1 man indicated they were vegetarian. Figure 1 shows the consumption frequency of different kinds of meat as stated by the participants of the study. Table 3 shows the effect of the frequency of consumption of meat on the lipid profile. Pork and poultry were consumed most often: 70.7% (pork) and 63.9% (poultry) of the participants indicated that they consumed these meats 1 – 2 times per week.

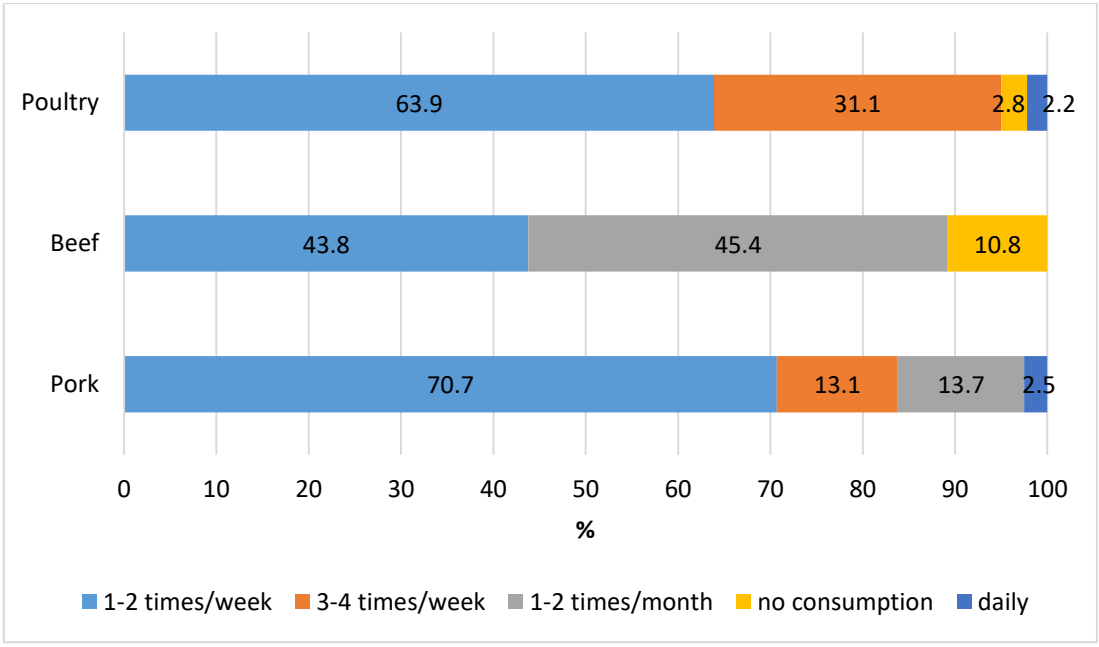

Figure 1 Percentages of consumption frequencies of meat of all respondents (n = 800).

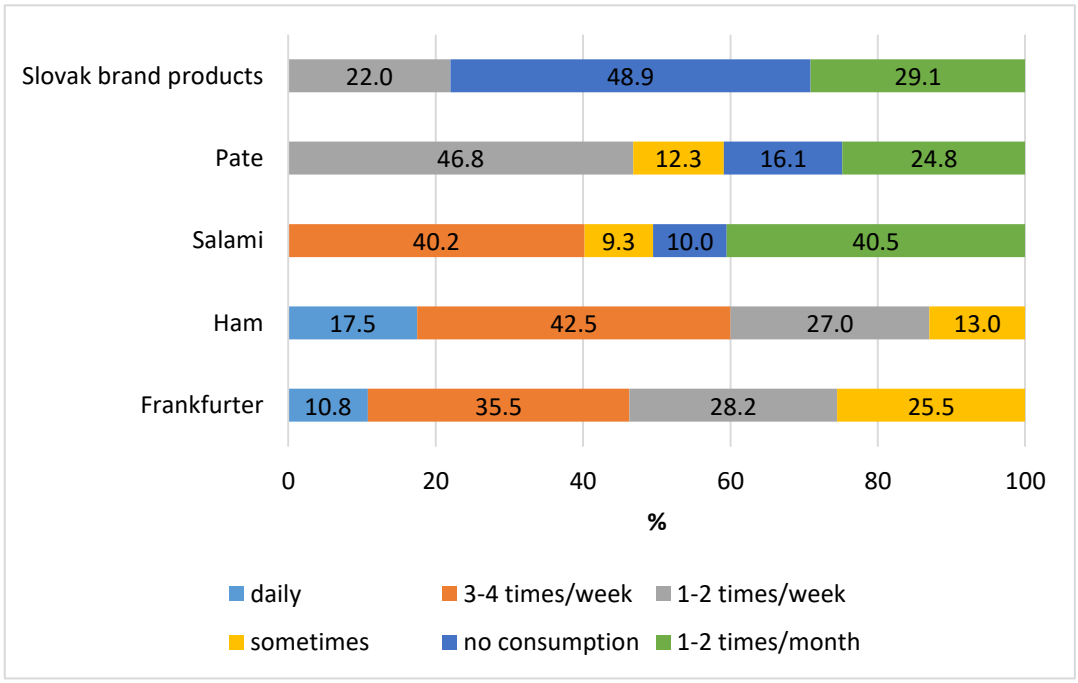

Figure 2 Percentages of consumption frequencies of meat products of all respondents (n = 800).

Table 1 Basic characteristics of study participants (n = 800).

Characteristic	Average ±SD	Min	Max
Age (yrs)	61.13 ±10.47	20.00	101.00
Height (m)	1.75 ±0.07	1.57	1.94
Weight (kg)	90.67 ±15.23	58.00	178.00
BMI ($kg.m^{-2}$)	29.34 ±4.43	17.90	52.00
TC ($mmol.L^{-1}$)	4.68 ±1.25	3.98	9.76
LDL-C ($mmol.L^{-1}$)	2.88 ±0.98	0.61	7.19
HDL-C ($mmol.L^{-1}$)	1.16 ±0.39	0.45	4.01
TG ($mmol.L^{-1}$)	1.73 ±0.93	0.43	7.39
GLU ($mmol.L^{-1}$)	6.66 ±2.31	3.98	24.12

Note: SD – standard deviation; Min – minimum value; Max – maximum value; BMI – Body mass index; TC – total cholesterol; (LDL-C) – LDL cholesterol; (HDL-C) – HDL cholesterol; TG – triglycerides; GLU – glucose.

Table 2 Demographic characteristics of study participants (n = 800).

Characteristics	n	%
Social status		
employed	273	34.2
unemployed	127	15.7
retiree	400	50.1
Family status		
married	582	72.7
divorced	111	13.9
widower	107	13.4
Education		
basic	98	12.2
apprenticeship	234	29.4
secondary	302	37.7
higher	166	20.7
Physical activity		
15 – 30 minutes per day	285	35.6
30 – 60 minutes per day	161	20.1
more than 1 hours per day	354	44.3
Smoker		
yes	251	31.4
no	549	68.6

Table 3 Effect of the frequency of consumption of meat on lipid profil (mmol.L^{-1}).

Frequency of consumption	TC (mmol.L^{-1})	LDL-C (mmol.L^{-1})	HDL-C (mmol.L^{-1})	TG (mmol.L^{-1})
Pork				
3 – 4 times per week	4.87 ±0.16	2.95 ±0.13	1.16 ±0.06	2.03 ±0.12
1 – 2 times per week	4.69 ±0.07	2.81 ±0.06	1.19 ±0.02	1.69 ±0.05
1 – 2 times per month	4.77 ±0.15	2.92 ±0.13	1.18 ±0.06	1.94 ±0.12
p – value	0.032[a]; 0.039[b]	>0.05	>0.05	0.047[a]
Beef				
1 – 2 times per week	4.62 ±0.09	2.84 ±0.39	1.17 ±0.03	1.70 ±0.06
1 – 2 times per month	4.51 ±0.09	3.40 ±0.40	1.21 ±0.03	1.77 ±0.07
no consumption	4.35 ±0.18	3.08 ±0.78	1.17 ±0.06	1.87 ±0.13
p – value	>0.05	>0.05	>0.05	>0.05
Poultry				
daily	4.79 ±0.38	2.90 ±2.32	0.88 ±0.14	1.99 ±0.09
3 – 4 times per week	4.70 ±0.10	2.85 ±0.62	1.18 ±0.04	1.81 ±0.08
1 – 2 times per week	4.55 ±0.07	2.57 ±0.43	1.19 ±0.03	1.74 ±0.05
p – value	>0.05	>0.05	>0.05	>0.05

Note: TC – total cholesterol; (LDL-C) – LDL cholesterol; (HDL-C) – HDL cholesterol; TG – triglycerides; [a]Significant difference between between 1 – 2 times per week and 3 – 4 times per week; [b]Significant difference between between 1 – 2 times per week and 1 – 2 times per month.

Similarly, **Schmid et al. (2017)** found out that, the consumption frequency of beef, pork, and poultry of elderly Swiss population is the highest, with ≥50% of the participants consuming these types of meats at least once a week. **Kopčeková et al. (2015)** in 204 patients with cardiovascular diseases have recorded consumption of meat more than four times per week in 60.28% of men, while more than 30% of men eat meat daily. Respondents indicated poultry and pork as the most commonly consumed meat. **Escriba-Perez et al. (2017)** monitored the consumption of meat in 800 respondents aged 25 to 75 years. Most commonly consumed was chicken, which consumed up to 90.87% of respondents at least once a week. The second most frequently consumed was beef (63.62%), and the third was pork (52.62%).

High concentrations of total cholesterol, LDL cholesterol, and triacylglycerols indicate that the individual is at risk for the onset of cardiovascular disease **(Wooton and Lynne, 2017)**. Elevated serum LDL-C is a long-established risk factor for the development of heart disease; however, the relationship between serum concentrations of LDL-C and dietary cholesterol is not clear **(Zachary et al., 2017)**. Reducing high blood cholesterol is thus important for CVD prevention **(Grundy et al., 1990; Cohen et al., 2006)**. LDL-C is a measure of the total cholesterol content of LDL particles, reflecting both the number of LDL particles and their cholesterol content. Most current guidelines include LDL-C as a primary target for initiating and adjusting lipid-lowering interventions **(Stone et al., 2014; Jacobson et al., 2014)**.

Table 4 Effect of the frequency of consumption of selected processed meat on lipid profile.

Frequency of consumption	TC (mmol.L^{-1})	LDL-C (mmol.L^{-1})	HDL-C (mmol.L^{-1})	TG (mmol.L^{-1})
Frankfurter				
daily	4.45 ±0.18	2.86 ±0.15	1.05 ±0.07	1.52 ±0.14
3 – 4 times per week	4.47 ±0.10	2.75 ±0.08	1.25 ±0.04	1.67 ±0.07
1 – 2 times per week	4.84 ±0.11	2.68 ±0.09	1.11 ±0.04	1.80 ±0.08
Sometimes	4.52 ±0.12	2.62 ±0.10	1.26 ±0.05	1.74 ±0.09
p – value	>0.05	0.046[a]	>0.05	0.012[b]; 0.017[c]
Ham				
Daily	4.50 ±0.14	2.78 ±0.67	1.12 ±0.05	1.62 ±0.11
3 – 4 times per week	4.62 ±0.09	2.76 ±0.43	1.21 ±0.03	1.80 ±0.07
1 – 2 times per week	4.66 ±0.11	2.91 ±0.53	1.14 ±0.04	1.92 ±0.09
Sometimes	4.52 ±0.16	2.84 ±0.45	1.28 ±0.06	1.69 ±0.13
p – value	>0.05	>0.05	>0.05	>0.05
Salami				
3 – 4 times per week	4.55 ±0.12	2.74 ±0.38	1.16 ±0.03	1.87 ±0.06
1 – 2 times per month	4.50 ±0.07	2.70 ±0.28	1.18 ±0.02	1.78 ±0.06
Sometimes	4.88 ±0.16	2.51 ±0.57	1.13 ±0.05	1.49 ±0.11
no consumption	4.53 ±0.15	2.87 ±0.54	1.15 ±0.05	1.99 ±0.12
p – value	>0.05	0.006[d]	>0.05	>0.05
Pate				
1 – 2 times per week	4.62 ±0.08	2.84 ±0.07	1.21 ±0.03	1.78 ±0.07
1 – 2 times per month	4.72 ±0.11	2.83 ±0.09	1.19 ±0.04	1.76 ±0.09
Sometimes	4.76 ±0.16	2.80 ±0.13	1.08 ±0.06	1.70 ±0.13
no consumption	4.43 ±0.14	2.75 ±0.12	1.20 ±0.05	1.65 ±0.11
p – value	>0.05	>0.05	>0.05	>0.05
Slovak brand products (sausage, headcheese and others)				
1 – 2 times per week	4.62 ±0.08	2.83 ±0.07	1.16 ±0.03	1.81 ± 0.07
1 – 2 times per month	4.52 ±0.07	2.81 ±0.06	1.20 ±0.02	1.72 ±0.06
no consumption	4.55 ±0.05	2.77 ±0.04	1.14 ±0.02	1.76 ±0.05
p – value	>0.05	>0.05	>0.05	>0.05

Note: SD – standard deviation; Min – minimum value; Max – maximum value; TC – total cholesterol; (LDL-C) – LDL cholesterol; (HDL-C) – HDL cholesterol; TG – triglycerides; [a]Significant difference between 1 times per week and 2 – 3 times per week; [b]Significant difference between 1 times per week and daily; [c]Significant difference between 2 – 3 times per week and sometimes; [d]Significant difference between 1 – 2 times per week and sometimes.

Red meat intake is commonly considered a risk factor for CVD because of its saturated fat and cholesterol contents **(Rohrmann and Linseisen, 2016)**.

Our results show, that most respondents consume meat 1 – 2 times per week, while we did not notice a significant effect (p >0.05) of the type of meat on the lipid profile.

The highest T-C, LDL-C, and TG values were seen in men who consume pork 3 – 4 times per week. Statistically, significant was the only effect of pork meat on total cholesterol and triglycerides (p <0.05). In the consumption of beef and poultry, there was a non-significant effect on biochemical parameters of blood (p >0.05). **Kopčeková et al. (2015)** in 204 patients with cardiovascular diseases found in both men and women in significantly higher values of HDL for the less frequent consumption, while the values of triglycerides and LDL cholesterol were higher for more frequent consumption. **Kontogianni et al. (2008)** found that a high intake of red meat (more than 8 servings/month) was associated with an increased risk of acute coronary syndrome, but low income (less than four servings/month) showed no association. A recent meta-analysis of 24 randomized controlled trials assessing the effects of red meat intake on CVD risk factors concluded that ≥0.5 serving/day of red meat did not influence blood lipids, lipoproteins, or blood pressure in comparison with <0.5 serving per day **(O'Connor et al., 2017)**. According to **Guasch-Ferré et al. (2019)** findings from the present systematic review and meta-analysis showed that total red meat intake did not differentially influence blood lipids and apolipoproteins, except triglycerides, when all comparison diets were analyzed together.

Processed meat consumption

Processed meat includes meat products that have been modified to change the taste or extend shelf life through curing, smoking, salting, or adding preservatives. Frequently consumed examples are: ham, sausages, salami, bacon, hot dogs, corned beef, beef jerky, ham, canned meat, and meat-based sauces **(Rohrmann et al., 2013; Clonan, Roberts and Holdsworth, 2016)**. Accumulating evidence links excessive consumption of processed meat, and to a lesser extent unprocessed red meat, to an increased risk of obesity, diabetes, cardiovascular diseases, and some cancers **(Micha and Mozaffarian**, **2010; Zeng et al., 2019)**.

Figure 2 shows the consumption frequency of different kinds of processed meat as stated by the participants of the study. Table 4 shows the effect of the frequency of

consumption of selected processed meat on the lipid profile.

Most respondents consume frankfurters (hot dogs) 3 – 4 times per week (35.5%) or 1 – 2 times per week (28.2%). Approximately 11% of respondents consume frankfurters daily, which is associated with non-significant higher LDL and lower HDL levels (p >0.05). We recorded a significant effect (p <0.05) of the consumption of frankfurters on the lipid profile. Almost half of the respondents consume meat pate 1 – 2 times per week and 24.8% only 1 – 2 times per month. Most respondents consume ham 3 – 4 times per week (42.5%), daily consumption of ham was recorded in 17.5% of patients. Different frequency of ham and meat pate consumption show non-significant changes for the lipid profile (p >0.05). Up to 40.2% of respondents consume salami 3 – 4 times/week, and we recorded a significant effect on LDL levels between consumption 1 – 2 times/week and sometimes (p <0.05). We also monitored the consumption of traditional Slovak brand products (sausage, headcheese, and others). Processed meats such as sausages have a higher content of saturated fatty acids and cholesterol than fresh red meat; reaching the proportion of fat in sausages more than 50% of weight **(Lajous et al., 2014)**. Almost half of the respondents (48.9%) state that they do not consume sausage, headcheese, and others at all. 29.1% of patients consume this product 1 – 2 times per month and 22.0% 1 – 2 times per week. Respondents who consume sausage, headcheese, and other products 1 – 2 times a week have non-significant higher T-C, LDL, TG, and lower HDL compared to less frequent consumption.

Micha and Mozaffarian (2010) in their meta-analysis of 20 studies (17 prospective cohorts and 3 cases control studies) that included 1218380 individuals concluded that intake of processed, but not red, meat was associated with an increased incidence of coronary heart disease and the authors speculate that the higher sodium and nitrate content of processed meat might contribute to their impact on CVD. This investigation in EPIC, including nearly half a million participants across 10 European countries and more than 5000 cardiovascular events, confirms that consumption of processed meat is strongly associated with CVD risk, and that consumption of unprocessed red meat has little to no association **(Rohrmann et al., 2013)**. **Watson and Preedy (2013)** report the results of research that focused on the effect of regular consumption of processed red meat (25, 75 grams or more per day) in 37035 healthy people. Probands who consumed 75 or more grams of meat products per day were 28% more likely to have heart failure than those who consumed less than 25 grams of meat products per day. Probands who consumed the most meat products had at least twice the risk of dying from CVD compared to those who consumed them.

CONCLUSION

In our study, we observed the associations between consumption of meat and meat products and lipid profile in a group of randomly selected patients with cardiovascular disease. Most participants consumed meat and meat products regularly. High consumption of meat, mainly pork and processed meat seems to be associated with higher levels of total cholesterol, LDL cholesterol, and triglycerides. This study offers support to the perception that food consumption is an important determinant in cardiovascular disease and its risk factors. As diet is a modifiable CVD risk factor, health promotion activities should consider specific advice on lowering processed meat consumption and, to a lesser extent, red meat consumption. Results like ours strongly suggest that to accurately investigate this relationship in the future, both red and processed meat must be analyzed separately. Further studies are needed to examine the role of meat and meat products in the prevention and management of cardiovascular diseases. A healthy lifestyle, including a healthy diet is the best strategy for the prevention of cardiovascular disease and other diseases.

REFERENCES

Biesalski, H. K. 2005. Meat as a component of a healthy diet - are there any risks or benefits if meat is avoided in the diet? *Meat Sci.*, vol. 70, no. 3, p. 509-524. https://doi.org/10.1016/j.meatsci.2004.07.017

Boirie, Y., Morio, B., Caumon, E., Cano, N. J. 2014. Nutrition and protein energy homeostasis in elderly. *Mech. Ageing Dev.*, vol. 136-137, p. 76-84. https://doi.org/10.1016/j.mad.2014.01.008

Clonan, A., Roberts, K. E., Holdsworth, M. 2016. Socioeconomic and demographic drivers of red and processed meat consumption: implications for health and environmental sustainability. *Proc. Nutr. Soc.*, vol. 75, no. 3, p. 367-373. https://doi.org/10.1017/S0029665116000100

Cohen, J. C., Boerwinkle, E., Mosley, Jr. T. H., Hobbs, H. H. 2006. Sequence variations in PCSK 9, low LDL, and protection against coronary heart disease. *N. Engl. J. Med.*, vol. 354, p.1264-1272. https://doi.org/10.1056/NEJMoa054013

Escriba-Perez, C., Baviera-Puig, A., Buitrago-Vera, J., Montero-Vicente, L. 2017. Consumer profile analysis for different types of meat in Spain. *Meat Science*, vol. 129, p. 120-126. https://doi.org/10.1016/j.meatsci.2017.02.015

Fernandez, M. L. 2012. Rethinking dietary cholesterol. *Curr. Opin. Clin. Nutr. Metab. Care*, vol. 15, no. 2, p. 117-121. https://doi.org/10.1097/MCO.0b013e32834d2259

GBD 2016 Risk Factors Collaborators. 2016. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet*, vol. 390, p. 1345-1422. https://doi.org/10.1016/S0140-6736(17)32366-8

Gaziano, T. A., Bitton, A., Anand, S., Abrahams-Gessel, S., Murphy, A. 2010. Growing epidemic of coronary heart disease in low- and middle-income countries. *Curr. Probl. Cardiol.*, vol. 35, no. 2, p. 72-115. https://doi.org/10.1016/j.cpcardiol.2009.10.002

Gille, D. 2010. Overview of the physiological changes and optimal diet in the golden age generation over 50. *Eur. Rev. Aging Phys. Act.*, vol. 7, p. 27-36. https://doi.org/10.1007/s11556-010-0058-5

Godfray, C. J., Aveyard, P., Garnett, T., Key, T., Lorimer, J., Pirrehumbert, R. T., Scarboroughi, P., Springmann, M., Jebb, S. 2018. Meat consumption, health, and the environment. *Science*, vol. 361, no. 6399, p. 1-8. https://doi.org/10.1126/science.aam5324

Grundy, S. M., Wilhelmsen, L., Rose, G., Campbell, R. W., Assman, G. 1990. Coronary heart disease in high-risk populations: lessons from Finland. *Eur. Heart J.*, vol. 11, no.

5, p. 462-471. https://doi.org/10.1093/oxfordjournals.eurheartj.a059730

Guasch-Ferré, M., Satija, A., Blondin, S. A., Janiszewski, M., Emlen, E., O'Connor, L. E., Campbell, W. W., Hu, F. B., Willett, W. C., Stampfer, M. J. 2019. Meta-analysis of randomized controlled trials of red meat consumption in comparison with various comparison diets on cardiovascular risk factors. *Circulation*, vol. 139, p. 1828-1845. https://doi.org/10.1161/CIRCULATIONAHA.118.035225

Jacobson, T. A., Ito, M. K., Maki, K. C., Orringer, C. E., Bays, H. E., Jones, P. H., McKenney, J. M., Grundy, S. M., Gill, E. A., Wild, R. A., Wilson, D. P., Brown, W. V. 2014. National Lipid Association recommendations for patient – centered management of dyslipidemia: part 1-executive summary. *J. Clin. Lipidol.*, vol. 8, no. 5, p. 473-488. https://doi.org/10.1016/j.jacl.2014.07.007

Klurfeld, D. M. 2015. Research gaps in evaluating the relationship of meat and health. *Meat Sci.*, vol. 109, p. 86-95. https://doi.org/10.1016/j.meatsci.2015.05.022

Kontogianni, M. D., Panagiotakos, D. B., Pitsavos, C., Chrysohoou, C., Stefanadis, C. 2008. Relationship between meat intake and the development of acute coronary syndromes: The CARDIO2000 case– Control study. *Eur. J. Clin. Nutr.*, vol. 62, p. 171-177. https://doi.org/10.1038/sj.ejcn.1602713

Kopčeková, J., Lorková, M., Habánová, M., Chlebo, P., Ferenčíková, Z., Chlebová, Z. 2015. The occurence of risk factors of cardiovascular diseases and the effect of selected dietary habits on the lipid profile and body mass index. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 9, no. 1, p. 330-336. https://doi.org/10.5219/491

Lajous, M., Bijon, A., Fagherazzi, G., Rossignol, E., Boutron-Ruault, M. C., Clavel- Chapelon, F. 2014. Processed and unprocessed red meat consumption and hypertension in women. *Am. J. Clin. Nutr.*, vol. 100, p. 948-952. https://doi.org/10.3945/ajcn.113.080598

Lawrence, G. D. 2013. Dietary fats and health: dietary recommendations in the context of scientific evidence. *Adv. Nutr.*, vol. 4, no. 3, p. 294-302. http://dx.doi.org/10.3945/an.113.003657

Linseisen, J., Rohrmann, S., Norat, T., Gonzalez, C. A., Iraeta, M. D., Gómez, P. M., Chirlaque, M. D., Pozo, B. G., Ardanaz, E., Mattisson, I., Pettersson, U., Palmqvist, R., Guelpen, B. V., Bingham, S. A., McTaggart, A., Spencer, E. A., Overvad, K., Tjønneland, A., Stripp, C., Clavel-Chapelon, F., Kesse, E., Boeing, H., Klipstein-Grobusch, K., Trichopoulou, A., Vasilopoulou, E., Bellos, G., Pala, V., Masala, G., Tumino, R., Sacerdote, C., Del Pezzo, M., Bueno-de-Mesquita, H. B., Ocke, M. C., Peeters, P. H. M., Engeset, D., Skeie, G., Riboli, E. 2006. Dietary intake of different types and characteristics of processed meat which might be associated with cancer riskeresults from the 24-hour diet recalls in the European Prospective Investigation into Cancer and Nutrition (EPIC). *Public Health Nutr.*, vol. 9, p. 449-464. https://doi.org/10.1079/phn2005861

Lippi, G., Mattiuzzi, C., Cervellin, G. 2016. Meat consumption and cancer risk: a critical review of published meta-analyses. *Crit. Rev. Oncol. Hematol.*, vol. 97, p. 1-14. https://doi.org/10.1016/j.critrevonc.2015.11.008

Löser, C. 2014. Causes and clinical sign of malnutrition. *Ther Umsch*, vol. 71, p. 135-139. https://doi.org/10.1024/0040-5930/a000494

Maki, K. C., Van Elswyk, M. E., Alexander, D. D., Rains, T. M., Sohn, E. L., McNeill, S. 2012. A meta-analysis of randomized controlled trials that compare the lipid effects of beef versus poultry and/or fish consumption. *J. Clin. Lipidol.*, vol. 6, no. 4, p. 352-361. https://doi.org/10.1016/j.jacl.2012.01.001

McAfee, A. J., McSorley, E. M., Cuskelly, G. J., Moss, B. W., Wallace, J. M., Bonham, M. O., Fearon, A. N. 2010. Red meat consumption: an overview of the risks and benefits. *Meat Sci.*, vol. 84, no. 1, p. 1-13. https://doi.org/10.1016/j.meatsci.2009.08.029

Micha, R., Mozaffarian, D. 2010. Saturated fat and cardiometabolic risk factors, coronary heart disease, stroke, and diabetes: a fresh look at the evidence. *Lipids*, vol. 45, no. 10, p. 893-905. https://doi.org/10.1007/s11745-010-3393-4

Micha, R., Michas, G., Mozaffarian, D. 2012. Unprocessed red and processed meats and risk of coronary artery disease and type 2 diabetes–an updated review of the evidence. *Curr. Atheroscler. Rep.*, vol. 14, p. 515-524. https://doi.org/10.1007/s11883-012-0282-8

Mittal, B. V., Singh, A. K. 2010. Hypertension in the developing world:challenges and opportunities. *AJKD*, vol. 55, no. 3, p. 590-598. https://doi.org/10.1053/j.ajkd.2009.06.044

Mozaffarian, D., Micha, R., Wallace, S. 2010. Effects on coronary heart disease of increasing polyunsaturated fat in place of saturated fat: a systematic review and meta-analysis of randomized controlled trials. *PLoS Med.*, vol. 7, p. e1000252. https://doi.org/10.1371/journal.pmed.1000252

Mozaffarian, D., Ludwig, D. S. 2015. The 2015 US dietary guidelines: lifting the ban on total dietary fat. *JAMA*, vol. 313, p. 2421-2422. https://doi.org/10.1001/jama.2015.5941

Mozaffarian, D. 2016. Dietary and policy priorities for cardiovascular disease, diabetes, and obesity: a comprehensive review. *Circulation*, vol. 133, p. 187-225. https://doi.org/10.1161/CIRCULATIONAHA.115.018585

O'Connor, L. E., Kim, J. E., Campbell, W. W. 2017. Total red meat intake of ≥0.5 servings/d does not negatively influence cardiovascular disease risk factors: a systemically searched meta-analysis of randomized controlled trials. *Am. J. Clin. Nutr.*, vol. 105, no. 1, p. 57-69. https://doi.org/10.3945/ajcn.116.142521

Pan, A., Sun, Q., Bernstein, A. M., Schulze, M. B., Manson, J. E., Stampfer, M. J., Willet, W. C., Hu, F. B. 2012. Red meat consumption and mortality: results from 2 prospective cohort studies. *Arch. Intern. Med.*, vol. 172, no. 7, p. 555-563. https://doi.org/10.1001/archinternmed.2011.2287

Pereira, P. M., Vicente, A. F. 2013. Meat nutritional composition and nutritive role in the human diet. *Meat Sci.*, vol. 93, no. 3, p. 586-592. https://doi.org/10.1016/j.meatsci.2012.09.018

Pfeiler, T. M., Egloff, B. 2018. Personality and meat consumption: The importance of differentiating between type of meat. *Appetite*, vol. 130, p. 11-19. https://doi.org/10.1016/j.appet.2018.07.007

Rohrmann, S., Overvad, K., Bueno-de-Mesquita, H. B., Jakobsen, M. U., Egeberg, R., Tjønneland, A., Nailler, L., Boutron-Ruault, M. C., Clavel-Chapelon, F., Krogh, V., Palli, D., Panico, S., Tumino, R., Ricceri, F., Bergmann, M. M., Boeing, H., Li, K., Kaaks, R., Khaw, K. T., Wareham, N. J., Crowe, F. L., Key, T. J., Naska, A., Trichopoulou, A., Trichopoulos, D., Leenders, M., Peeters, P. H. M., Engeset, D., Parr, C. L., Skeie, G., Jakszyn, P., Sánchez, M. J., Huerta, J. M., Redondo, M. L., Barricarte, A., Amiano, P., Drake, I., Sonestedt, E., Hallmans, G., Johansson, I., Fedirko, V., Romieux, I., Ferrari, P., Norat, T., Vergnaud, A. C., Riboli, E., Linseisen, J. 2013. Meat consumption and mortality - results from the European Prospective Investigation into Cancer and Nutrition. *BMC Med.*, vol. 11, p. 63. https://doi.org/10.1186/1741-7015-11-63

Rohrmann, S., Linseisen, J. 2016. Processed meat: the real villain? *Proceedings of the Comparative Nutrition Society*, vol. 75, no. 3, p. 233-241. https://doi.org/10.1017/S0029665115004255

Salter, A. M. 2018. The effects of meat consumption on global health. *Rev. Sci. Tech.*, vol. 37, p. 47-55. https://doi.org/10.20506/rst.37.1.2739

Santarelli, R. L., Pierre, F., Corpet, D. E. 2008. Processed meat and colorectal cancer: a review of epidemiologic and experimental evidence. *Nutr. Cancer*, vol. 60, no. 2, p. 131134. https://doi.org/10.1080/01635580701684872

Schmid, A., Gille, D., Piccinali, P., Bütikofer, U. 2017. Factors predicting meat and meat products consumption among middle-aged and elderly people: evidence from a consumer survey in Switzerland. *Food. Nutr. Res.*, vol. 61, p. 1-11. https://doi.org/10.1080/16546628.2017.1308111

Stone, N. J., Robinson, J. G., Lichtenstein, A. H., Merz, C. N. B., Blum, C. B., Eckel, R. H., Goldberg, A. C., Gordon, D., Levy, D., Lloyd-Jones, D. M., McBride, P., Schwartz, J. S., Shero, S. T., Smith, S. C. Jr., Watson, K., Wilson, P. W. F. 2014. 2013 ACC / AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology / American Heart Association Task Forceon Practice Guidelines. *Circulation*, vol. 129, no. 25, p. 1-45. https://doi.org/10.1161/01.cir.0000437738.63853.7a

Wang, X., Lin, X., Ouyang, Y. Y., Liu, J., Zhao, G., Pan, A., Hu, F. B. 2016. Red and processed meat consumption and mortality: dose-response meta-analysis of prospective cohort studies. *Public Health Nutr.*, vol. 19, no. 5, p. 893-895. https://doi.org/10.1017/S1368980015002062

Watson, R. R., Preedy, R. V. 2013. *Bioactive food as dietary interventions for cardiovascular disease*. London : Academic press, p. 148. ISBN 978-0-12-396485-4

Webster-Gandy, J., Madden, A., Holdsworth, M. 2012. *Oxford Handbook of Nutrition and Dietetics.* Oxford : OUP, p. 818. ISBN 978-0-19-958582-3

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Wries, W., Murray, C. 2019. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet*, vol. 393, no. 10170, p. 447-492. https://doi.org/10.1016/S0140-6736(18)31788-4

Wooton, A., Lynne, M. 2017. Obesity and Type 2 Diabetes in Our Youth: A Recipe for Cardiovascular Diseas. *JNP*, vol. 13, no. 3, p. 222-227. https://doi.org/10.1016/j.nurpra.2016.08.035

Wu, J., Zeng, R., Huang, J., Li, X., Zhang, J., Ho, J., Zheng, Y. 2016. Dietary protein sources and incidence of breast cancer: a dose-response meta-analysis of prospective studies. *Nutrients*, vol. 8, no. 11, p. 730-750. https://doi.org/10.3390/nu8110730

Zachary, S., Clayton, M. S., Fusco, E., Kern, M. 2017. Egg consumption and heart health: A review. *Nutrition*, vol. 37, p. 79-85. https://doi.org/10.1016/j.nut.2016.12.014

Zeng, L., Ruan, M., Liu, J., Wilde, P., Naumova, E. N., Mozaffarian, D., Zhang, F. F. 2019. Trends in Processed Meat, Unprocessed RedMeat, Poultry, and Fish Consumption in theUnited States, 1999-2016. *J. Acad. Nutr. Diet.*, vol. 119, no. 7, p. 1085-1098. https://doi.org/10.1016/j.jand.2019.04.004

Acknowledgments:

This paper was supported by the research projects of Cultural and Educational Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic (KEGA) 004SPU-4/2019.

Contact address:

*Jana Kopčeková, Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Human Nutrition, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, Tel.: +421376414249,
E-mail: jana.kopcekova@uniag.sk
ORCID: https://orcid.org/0000-0002-0989-7868

Jana Mrázová, Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Human Nutrition, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, Tel.: +421376414223,
E-mail: jana.mrazova@uniag.sk
ORCID: https://orcid.org/0000-0002-9540-1530

Martina Gažarová, Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Human Nutrition, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, Tel.: +421376414210,
E-mail: martina.gazarova@uniag.sk
ORCID: https://orcid.org/0000-0001-8275-7311

Marta Habánová, Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Human Nutrition, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, Tel.: +421376414467,
E-mail: marta.habanova@uniag.sk
ORCID: https://orcid.org/0000-0003-1721-7161

Corresponding author: *