DIETARY HABITS OF COLORECTAL CANCER PATIENTS – COMPARISON BETWEEN SLAVONIA AND DALMATIA

Marina Kunac[1], Ilijan Tomaš[2,3], Vesna Telesmanić Dobrić[4], Jelena Balkić Widmann[5], Milica Cvijetić Stokanović[1], Ines Banjari[1*]

[1]Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, 31000 Osijek, Croatia
[2]University Hospital Center Osijek, Department of Oncology, Josipa Huttlera 4, 31000 Osijek, Croatia
[3]Josip Juraj Strossmayer University of Osijek, Faculty of Medicine Osijek, Josipa Huttlera 4, 31000 Osijek, Croatia
[4]General Hospital Zadar, Department of Oncology, Iže Peričića 5, 23000 Zadar, Croatia
[5]University Hospital Centre Osijek, Department of Dietetics, Josipa Huttlera 4, 31000 Osijek, Croatia

Summary

Diet plays crucial role in colorectal cancer (CRC), from incidence to progression. It is the second cause of death due to carcinoma in Croatia, with significant regional differences. The aim of this observational study was to determine dietary habits of CRC patients, and whether their diet differs by region. A total of 60 patients with non-metastatic CRC, 30 from Slavonia and 30 from Dalmatia participated in the study. Two thirds of patients from both regions changed their diet for better after CRC diagnosis. However, one third of patients do not get any physical activity. Patients do not differ in their energy intake or intake of vitamins or minerals. Still, high contribution of fats (>40%) and low contribution of carbohydrates in the total daily energy intake was found. Contribution of proteins is higher in Slavonia (p=0.040). More patients from Dalmatia have intake of calcium <700 mg/day (43.3% vs 33.3%). Alcohol is consumed more often by patients from Dalmatia (p<0.001) and higher consumption of alcohol correlates with the high risk diet profile which was found in 66.7% of patients from Dalmatia in comparison to 36.7% patients from Slavonia (p=0.020). The results point out some regional differences in the diet which need further analysis.

Keywords: colorectal cancer; diet; regional differences

Introduction

In Europe, 4.4 million people annually are diagnosed with cancer, with 1.96 million cancer-related deaths, 12.5% of which are attributed to colorectal cancer (CRC) (WHO, 2020). Globally, CRC is the third most common cancer (WCRFI, 2020). The toll of cancer is experienced by the entire society, either directly or indirectly. For example, the global annual healthcare allocation for cancer patients is around € 900 billion (EC, 2020). The burden of cancer in 27 countries of the European Union (EU) in 2020 has risen up to 2.7 million new cases and 1.3 million deaths consequently. Colorectal cancer is the second most common cancer (11.8% of all new cases), and the second cause of death (12.5% of all cancer deaths) with high mortality rates especially in Eastern countries (ECIS, 2020). Early CRC diagnosis is crucial for survival (WCRFI, 2020).

The incidence of CRC is significantly higher in men (10.6% vs. 9.2%) (Ferlay et al., 2019), while women have a longer survival (58.7% vs. 59.2%) and lower mortality rates (6.3% vs. 8.8%). This, however, changes in women over 50 years (Yang et al., 2017), probably because of the changes in the sex hormones level in menopause (Majek et al., 2013). In addition, women are more likely to have the so-called right (proximal) CRC which is more aggressive in relation to the left (distal) CRC which is more common in men (Yang et al., 2017).

The majority of CRC cases (70%) are spontaneous and the remaining 10 to 30% are of hereditary origin (Banjari and Hjårtaker, 2018). For spontaneous CRC the most important risk factors are diet and physical activity (Banjari and Fako, 2013). Poor diet and lifestyle habits can overcome positive genetic family history or diagnosis of some of the inflammatory bowel diseases (Johnson et al., 2013). The strongest correlation was found for the consumption of processed and red meat, that is, heme iron (Abid et al., 2014), while for the total dietary intake of iron, the results are inconsistent (Ashmore et al., 2016; Fonseca-Nunes et al., 2013; Bastide et al., 2011).

Daily consumption of 50 g of processed meat (salted and smoked meat, e.g. sausages, kulen, dry cured ham or bacon) increases the risk of CRC by 18% (Abid et al., 2014). Red meat (beef, pork and game meat) increases the risk by 12% (Zhao et al., 2013). Diet plays crucial role in survival too (Banjari, 2018), along with pre-existence of obesity and lack of physical activity.

Diet is very diverse across Croatian regions, from Hungarian-Turkish-like in the eastern regions, Austrian-like in the northern parts to the Mediterranean type in the coastal regions. Culinary diversity is not solely restricted to Croatia and can be seen in many countries across

*Corresponding author: ibanjari@ptfos.hr

Europe and world (Anderson et al., 2016; Mertens et al., 2019). Yet, these regional differences become evident once CRC incidence and mortality are compared (Banjari and Kožić, 2018).

The traditional dietary patterns in continental (Eastern) Croatia can be characterized as the high-risk diet for CRC (due to significant consumption of processed and red meat, more saturated fats and the preference for spicy foods) (Banjari and Kožić, 2018). On the other hand, diet in the coastal region can be described as the Mediterranean type of diet or the CRC low-risk diet, because of the well-proven beneficial effects on the CRC risk (Farinetti et al., 2017). Still, even though nutrition has the strongest impact on CRC risk (Johnson et al., 2013; WCRFI and AICR, 2018), latest incidence rates per 100 000 population from 2019, for C18 (colon cancer excluding rectum) show that CRC is more common in Dalmatia than in Slavonia (43.3 in Osijek-Baranja County (Eastern Croatia) and 60.0 in Zadar and 69.9 in Split-Dalmatia County (coastal regions)) (HZJZ, 2021). The aim of this study was to compare dietary pattern of CRC patients from Slavonia and Dalmatia.

Participants and methods

Study type and participants

We conducted an observational study encompassing non-metastatic CRC patients, diagnosed with either colon or rectal cancer for at least 6 months, both gender, at least 40 years old. The recruitment was done through patient registry of General hospital Zadar (N=30) and University Hospital Centre Osijek (N=30). In every region, 16 men and 14 women participated in the study. Study was approved by ethics committee of General hospital Zadar and University Hospital Centre Osijek. After patients gave written consent to participate in the study, they were interviewed via telephone to complete all questionnaires.

Questionnaires

Study specific questionnaire included general questions (e.g. age, gender), basic socio-demographic data (e.g. education level, employment, income, household members), health information (e.g. when was CRC diagnosed, constipation, sleep weight change, medications, supplement use), and general diet and lifestyle habits (e.g. number of meals per day, meal skipping, smoking, alcohol consumption, physical activity, preference of foods). Study subjects also completed one 24-hour dietary recall, which was used to calculate macro- and micro-nutrient consumption. Calculations were done by MeDietetic Software (MeDietetic, 2022), which uses national food composition database. These calculations were later compared with referent values for adults for particular nutrients (EFSA, 2019).

Based on the self-reported weight and height, Body Mass Index was calculated and CRC patients were categorized according to their nourishment status (WHO, 2010).

Statistical analysis

Software package Statistica 14.0 was used for statistical analysis, with selected level of significance at 0.05. Graphic analysis was conducted with MS Office Excel 2016 package.

The normality of data distribution was tested using the non-parametric Kolmogorov-Smirnov test, along with the comparison of medians, the comparison of the arithmetic means and by creating histograms. Given that all values are normally distributed, parametric statistical tests were used.

Pearson's correlation test and student's t-test for independent variables was used, along with Chi square test for the comparison of categorical data.

Results and discussion

Patients' general characteristics are shown in Table 1. Patients from Slavonia were significantly younger in comparison to patients from Dalmatia. Age is one of the risk factors for CRC (WCRF and AICR, 2018). People who are 50 years or older have 5% higher risk for CRC (HZJZ, 2018), but globally, CRC incidence is rising among people who are younger than 50 years (Voigtländer et al., 2022). In this research, only three patients were younger than 50 years. Still, younger people tend to have a more aggressive form of CRC, but better survival rates in comparison to patients who are 50+ years old (Steele et al., 2014).

Table 1. General characteristics of CRC patients from Slavonia (n=30) and Dalmatia (n=30)

Characteristics	Slavonia (n=30)		Dalmatia (n=30)		p
	Mean ± SD	Min - Max	Mean ± SD	Min - Max	
Age (years)	61 ± 5	51 – 69	67 ± 11	43 - 82	0.010*
BMI (kg/m²)	26.3 ± 4.3	20.7 – 36.6	27.6 ± 4.4	18.6 – 39.5	0.272
Time from CRC diagnosis (months)	11 ± 3	1 - 16	39 ± 38	6 – 192	<0.001*
Symptoms prior the diagnosis (months)	6 ± 13	0 - 72	4 ± 6	0 - 24	0.303
Weight loss (kg)	-10.6 ± 10.0	-40 – 6	-8.6 ± 7.9	-25 – 0	0.378

BMI – Body Mass Index, SD – standard deviation, Min – minimum value, Max – maximum value; T-test for independent variables; *statistically significant at p<0.05

There was no significant difference in the average BMI (Table 1), but more patients from Dalmatia are overweight in comparison to patients from Slavonia (50% vs 33%, Figure 1). Between 30 and 70% of CRC has been linked to obesity and overweight, and the risk seem to be more pronounced in men (Duraiyarasan et al., 2022).
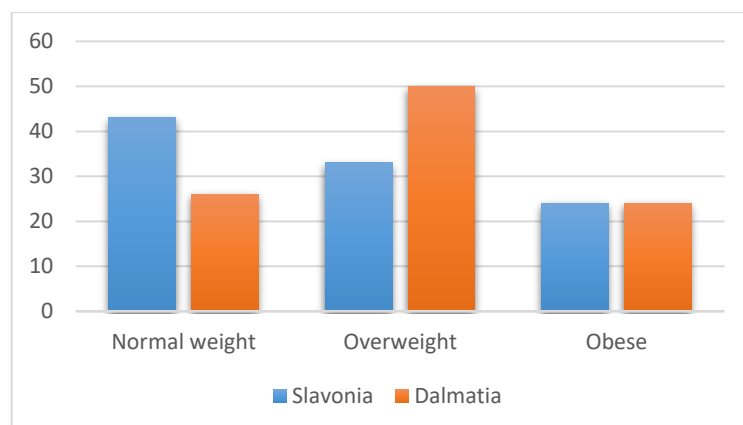

Figure 1. Distribution of CRC patients from Slavonia (n=30) and Dalmatia (n=30) according to their nourishment status

Patients do not differ in the time when the first symptoms appeared prior to the diagnosis (Table 1). Blood in stool and frequent diarrhoea-like stool are the most common symptoms patients mentioned to have appeared before the diagnosis. Some patients also reported feeling tired, bloating, constipation, significant weight loss, iron deficiency anaemia and abdominal pain. Also, there was no difference in weight loss (Table 1). Patients with significant weight loss need close monitoring since it was shown that with every 5 kg weight loss, survival is lower by 25% (Kocarnik et al., 2017). In other words, weight loss is an independent risk factor for survival in CRC patients (Cong et al., 2018; Kuo et al., 2018), while weight gain after the diagnosis did not show to correlate with either poor outcome or survival (Meyerhardt et al., 2017; Cong et al., 2018).

Patients do not differ in their energy or macronutrient consumption (Table 2). Patients from Slavonia consume more complex carbohydrates in comparison to patients from Dalmatia (based on the ratio mono/poly) which is supported by the daily fibre consumption (23.2 ± 17.7 g in comparison to 19.3 ± 9.7 g). On the other hand, ratio between plant and animal proteins shows that patients from Slavonia consume more animal foods (Table 2). Patients from Dalmatia consume significantly more alcohol in comparison to patients from Slavonia (p=0.013, Table 2). Alcohol consumption >50 g/day for men and >25 g/day for women significantly increase the risk for CRC and CRC mortality (Rossi et al., 2018). Alcohol restriction is especially important for obese men who almost double the risk for CRC (Banjari, 2018). However, alcohol consumption in moderation has protective effect in CRC patients who are also diagnosed with diabetes (Walter et al., 2017). Alcohol changes folate metabolism in the liver and is a possible cause of liver metastases in CRC patients (Rossi et al., 2018).

Table 2. Average daily energy and macronutrient intake among CRC patients from Slavonia (n=30) and Dalmatia (n=30)

	Slavonia		Dalmatia		p
	Mean ± SD	Min - Max	Mean ± SD	Min - Max	
Energy (kJ)	9921 ± 4071	5253 - 20176	9522 ± 3094	4308 - 17614	0.670
Energy (Kcal)	2372 ± 974	1256 - 4825	2276 ± 739	1029 - 4209	0.667
Carbohydrates(g)	264.0 ± 148.3	112.8 – 856.7	229.0 ± 75.7	114.4 – 411.3	0.255
Ratio Mono/Poly	0.6 ± 0.4	0.1 – 1.8	0.8 ± 1.4	0.2 – 8.2	0.305
Total fats (g)	107.9 ± 57.8	52.6 – 267.5	112.2 ± 55.0	34.3 – 255.5	0.771
SFA (g)	34.3 ± 22.8	13.7 – 104.0	33.5 ± 19.0	3.9 – 86.7	0.885
MUFA (g)	39.3 ± 28.0	28.0 -124.9	47.2 ± 33.2	10.1 – 132.2	0.325
PUFA (g)	27.9 ± 15.3	10.3 – 74.6	24.1 ± 13.4	6.8 – 56.06	0.313
Cholesterol (mg)	353.4 ± 483.0	24.8 – 2782.0	480.7 ± 1360.0	0.0 – 7609.6	0.631
Proteins (g)	88.8 ± 36.3	34.5 – 204.1	76.9 ± 39.3	30.5 -39.3	0.226
Ratio Plant/Animal	0.9 ± 0.7	0.1 – 3.5	1.5 ± 4.6	0.0 – 25.8	0.452
Fibre (g)	23.2 ± 17.7	9.6 – 102.3	19.3 ± 9.7	1.8 – 47.8	0.291
Alcohol (g)	1.4 ± 5.3	0.0 – 21.5	8.7 ± 14.7	0.0 – 53.5	0.013*

Min – minimum value, Max – maximum value; Ratio Mono/Poli – ratio between mono- and polysaccharides, SFA – saturated fatty acids, MUFA – mono-unsaturated fatty acids, PUFA– poly-unsaturated fatty acids, Ratio Plant/Animal – ratio between plant and animal proteins
T-test for independent variables; *statistically significant at p<0.05

In comparison to recommended nutrient intake (EFSA, 2019) patients from both regions have much higher contribution of fats to the total daily energy intake (over 30%), while contribution of carbohydrates is lower from the recommended (50 – 55%). Lower death risk, regardless of the cause is related to daily contribution of carbohydrates to the total energy intake between 50 and 55% (Seidelmann et al., 2018). Also, low (< 40%), and high (> 70%) contribution of carbohydrates increase the risk of death by 20% and 23% respectively (Seidelmann et al., 2018).
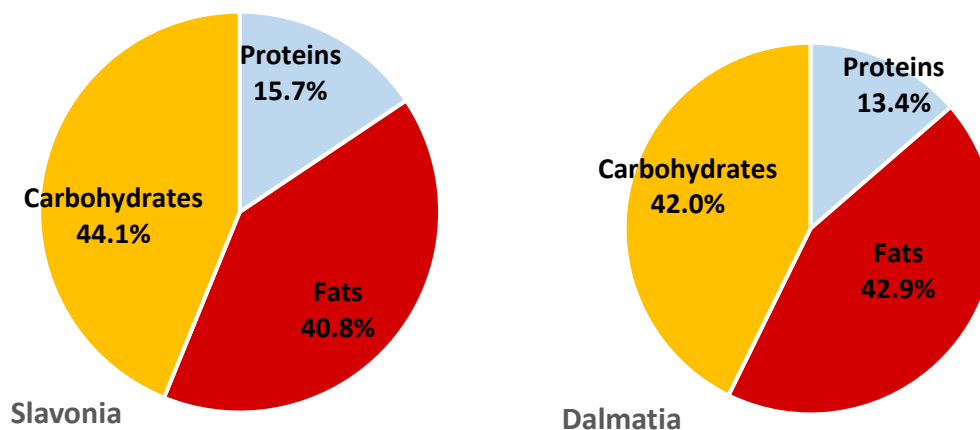

Figure 2. Contribution (%) of proteins, fats and carbohydrates to the total daily energy intake among CRC patients from Slavonia (n=30) and Dalmatia (n=30)

Average daily consumption of vitamins (Table 3) and minerals (Table 4) except for niacin and selenium do not differ significantly among CRC patients from Slavonia and Dalmatia. Vitamin D consumption is slightly higher in Dalmatia in comparison to Slavonia (1.363 ± 4.580 μg vs 1.348 ± 1.855 μg) while more vitamin B_{12} is consumed by patients from Slavonia (3.5 ± 4.9 mg vs 2.5 ± 4.5 mg). On the other hand, more calcium (706 ± 401 mg vs 651 ± 517 mg) and iron (12.9 ± 6.7 mg vs 12.0 ± 7.1 mg) is consumed by patients from Dalmatia. In comparison to recommendations (EFSA, 2019), both groups of patients consume more iron and vitamin B_{12} while vitamin D consumption is well below the recommended intake of 15 μg/day, as well as calcium consumption for which the recommended intake is 1000 mg/day. The strongest protective effect in CRC was found for calcium consumption exceeding 700 mg/day (Banjari, 2018). Calcium consumption below 700 mg/day was found in 10 patients from Slavonia and 13 patients from Dalmatia (not statistical significance).

Table 3. Average daily consumption of vitamins among CRC patients from Slavonia (n=30) and Dalmatia (n=30)

Vitamins	Slavonia		Dalmatia		p
	Mean ± SD	Min - Max	Mean ± SD	Min - Max	
Vitamin A (μg)	569 ± 1143	0 - 6196	688 ± 1033	0 - 4206	0.676
Vitamin D (μg)	1.348 ± 1.855	0.000 – 7.036	1.363 ± 4.580	0.000 – 25.274	0.987
Vitamin E (mg)	2.70 ± 3.45	0.32 – 17.37	4.68 ± 5.47	0.18 – 20.21	0.099
Vitamin K (μg)	142 ± 140	0 - 546	205 ± 254	0 - 1047	0.239
Vitamin C (mg)	111 ± 222	0 - 1228	96 ± 92	5 - 397	0.746
Vitamin B_1 (mg)	0.92 ± 0.73	0.32 – 3.45	0.80 ± 0.42	0.27 – 2.10	0.443
Vitamin B_2 (mg)	1.02 ± 0.61	0.41 – 2.96	0.94 ± 0.78	0.38 – 4.88	0.642
Niacin (mg)	15.1 ± 8.4	4.4 – 38.2	10.0 ± 6.9	3.0 – 35.5	0.012*
Vitamin B_6 (mg)	1.28 ± 0.79	0.18 – 3.34	1.01 ± 0.59	0.15 – 2.34	0.141
Biotin (μg)	23.99 ± 17.43	2.63 – 86.47	27.16 ± 64.88	0.60 – 365.91	0.797
Folates (μg)	159 ± 152	55 – 900	127 ± 83	10 – 378	0.993
Vitamin B_{12} (mg)	3.5 ± 4.9	0.0 – 24.5	2.5 ± 4.5	0.0 – 24.6	0.792

Min – minimum value, Max – maximum value; T-test for independent variables; *statistically significant at p<0.05

Table 4. Average daily consumption of minerals among CRC patients from Slavonia (n=30) and Dalmatia (n=30)

Minerals	Slavonia		Dalmatia		p
	Mean ± SD	Min - Max	Mean ± SD	Min - Max	
Sodium (g)	6906 ± 4999	2109 - 24844	5139 ± 3778	1040 - 21421	0.128
Potassium (g)	3201 ± 1797	966 - 9633	2702 ± 1069	1171 - 5663	0.197
Calcium (mg)	651 ± 517	101 - 2727	706 ± 401	110 - 2306	0.653
Magnesium (mg)	230 ± 149	16 - 603	218 ± 132	49 - 495	0.742
Phosphorus (mg)	1341 ± 526	583 - 3024	1304 ± 681	636 - 4551	0.815
Iron (mg)	12.0 ± 7.1	5.1 – 34.2	12.9 ± 6.7	5.2 – 37.9	0.635
Zinc (mg)	4.46 ± 2.86	0.00 – 13.83	3.24 ± 2.33	0.69 - 10,55	0.075
Copper (μg)	1.08 ± 1.02	0.05 – 5.55	0.76 ± 0.49	0.08 – 2.38	0.120
Manganese (mg)	797 ± 1158	0 - 5221	1142 ± 1212	0 - 5695	0.265
Selenium (μg)	148 ± 70	68 - 361	103 ± 63	13 - 298	0.010*

Min – minimum value, Max – maximum value; T-test for independent variables; *statistically significant at $p<0.05$

When all dietary characteristics are observed in relation to CRC effect (WCRF and AICR, 2018), we found that 11 patients from Slavonia and 20 patients from Dalmatia have diet which can be characterized as the "high-risk" diet (p=0.020; Chi square test). Patients from Slavonia have slightly better distribution of macronutrients in the daily energy intake, their consumption of dietary fibre is higher and they have lower alcohol consumption in comparison to patients from Dalmatia.

Conclusions

The results point out some regional differences in diet between Slavonia and Dalmatia that need more thorough examination in order to determine their role in the progression and survival of CRC patients. Nutrition education programs and/or provision of nutrition information (in a form of pamphlet or booklets) to CRC patients within hospitals is necessary to improve patients' knowledge and behaviour related to diet. That could have important implications in patients' treatment success, recovery and quality of life.

References

Abid, Z., Cross, A.J., Sinha, R. (2014): Meat, dairy, and cancer. *Am J Clin Nutr.* 100 (Suppl 1), 386S-93S.

Anderson, L., Merle Benbow, H., Manzin, G. (2016): Europe on a Plate: Food, Identity and Cultural Diversity in Contemporary Europe. *Australian & New Zealand Journal of European Studie.* 8 (1), 2-15.

Ashmore, J.H., Rogers, C.J., Kelleher, S.L., Lesko, S.M., Hartman, T.J. (2016): Dietary iron and colorectal cancer risk: a review of human population studies. *Crit Rev Food Sci Nutr.* 56 (6), 1012-1020.

Banjari, I. (2018): Kolorektalni karcinom i prehrana - što kažu dokazi?. *Znanstveno-stručni časopis za nutricionizam i dijetetiku Hrana u zdravlju i bolesti*, specijalno izdanje povodom 10. međunarodnog simpozija Štamparovi dani "Zdravi stilovi života" 58-63.

Banjari, I., Fako, J. (2013): The importance of an up-to-date evidence based diet planning for colorectal cancer patients. *Arch Oncol.* 21 (3/4), 160-162.

Banjari, I., Hjårtaker, A. (2018): Dietary sources of iron and vitamin B12: Is this the missing link in colorectal carcinogenesis? *Med Hypotheses* 116, 105-110.

Banjari, I., Kožić, S. (2018): Dietary intake of vitamin B12 in relation to diet and lifestyle characteristics in a population at high risk for CRC. *Central Eur J Pub Health* 26 (4), 253-259.

Bastide, N.M., Pierre, F.H.F., Corpet, D.E. (2011): Heme iron from meat and risk of colorectal cancer: a meta-analysis and a review of the mechanisms involved. *Cancer Prev Res.* 4 (2), 177-184.

Cong, Z., Wang, D., Cao, Y. (2018): The relationship between body mass index changes during chemotherapy and prognosis of patients with advanced colorectal cancer: A retrospective cohort study. *Medicine (Baltimore)* 97 (22), 18-43.

Duraiyarasan, S., Adefuye, M., Manjunatha, N., Ganduri, V., Rajasekaran, K. (2022): Colon Cancer and Obesity: A Narrative Review. *Cureus.* 14 (8), e27589.

EC, European Commission. Europe's Beating Cancer Plan: Let's strive for more. Published 4 February 2020. https://ec.europa.eu/health/non_communicable_disea ses/cancer_en

ECIS, European Cancer Information System. Estimates of cancer incidence and mortality in 2020, for all countries. https://ecis.jrc.ec.europa.eu/index.php

Farinetti, A., Zurlo, V., Manenti, A., Coppi, F., Mattioli, A.V. (2017): Mediterranean diet and colorectal cancer: A systematic review. *Nutrition* 43-44, 83-88.

EFSA, European Food Safety Authority: DRV Finder. https://multimedia.efsa.europa.eu/drvs/index.htm

Ferlay, J., Colombet, M., Soerjomataram, I., Mathers, C., Parkin, D.M., Piñeros, M., et al. (2019): Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. *Int J Cancer* 144 (8), 1941-1953.

Fonseca-Nunes, A., Jakszyn, P., Agudo, A. (2013): Iron and cancer risk—a systematic review and meta-analysis of the epidemiological evidence. *Cancer Epidemiol Biomarkers Prev.* 23 (1), 12-31.

HZJZ, Croatian Institute of Public Health (2018): Croatian National Cancer Registry. Cancer Incidence in Croatia in 2015. Bulletin No: 40. Zagreb: Croatian Institute of Public Health.

HZJZ, Croatian Institute of Public Health (2021): Croatian National Cancer Registry. Cancer Incidence in Croatia 2019. Bulletin No. 44. Zagreb: Croatian Institute of Public Health.

Johnson, C.M., Wei, C., Ensor, J.E., Smolenski, D.J., Amos, C.I., Levin, B., Berry, D.A. (2013): Meta-analyses of colorectal cancer risk factors. *Cancer Causes Control* 24 (6), 1207-1222.

Kocarnik, J.M., Hua, X., Hardikar, S., Robinson, J., Lindor, N.M., Win, A.K., et al. (2017): Long-term weight loss after colorectal cancer diagnosis is associated with lower survival: The Colon Cancer Family Registry. *Cancer* 123 (23), 4701-4708.

Kuo, Y.-H., Shi, C.-S., Huang, C.Y., Huang, Y.-C., Chin, C.-C. (2018): Prognostic significance of unintentional body weight loss in colon cancer patients. *Mol Clin Oncol.* 8 (4), 539-543.

Yang, Y., Wang, G., He, J., Ren, S., Wu, F., Zhang, J., Wang, F. (2017): Gender differences in colorectal cancer survival: A meta-analysis. *Int J Cancer.* 141 (10), 1942-1949.

Majek, O., Gondos, A., Jansen, L., Emrich, K., Holleczek, B., Katalinic, A., et al. (2013): Sex differences in colorectal cancer survival: population-based analysis of 164,996 colorectal cancer patients in Germany. *PLoS One* 8 (7), e68077.

MeDietetic Software, 2021. https://nutrition.medietetic.com/

Mertens, E., Kuijsten, A., Dofková, M., Mistura, L., D'Addezio, L., Turrini, A., et al. (2019): Geographic and socioeconomic diversity of food and nutrient intakes: a comparison of four European countries. *Eur J Nutr.* 58 (4), 1475-1493.

Meyerhardt, J.A., Kroenke, C.H., Prado, C.M., Kwan, M.L., Castillo, A., Weltzien, E., et al. (2017): Association of Weight Change after Colorectal Cancer Diagnosis and Outcomes in the Kaiser Permanente Northern California Population. *Cancer Epidemiol Biomarkers Prev.* 26 (1), 30-37.

Rossi, M., Anwar, M.J., Usman, A., Keshavarzian, A., Bishehsari, F. (2018): Colorectal Cancer and Alcohol Consumption—Populations to Molecules. *Cancers* 10 (2), 38.

Seidelmann, S.B., Claggett, B., Cheng, S., Henglin, M., Shah, A., Steffen, L.M. et al. (2019): Dietary carbohydrate intake and mortality: a prospective cohort study and meta-analysis. *Lancet Public Health* 3 (9), e419-e428.

Steele, R.S., Park, E.G., Johnson, K.E., Stojadinović, A., Causey, W.M. (2014): The Impact of Age on Colorectal Cancer Incidence, Treatment, and Outcomes in an Equal-Access Health Care System. *Dis Colon Rectum* 57 (3), 303-310.

Voigtländer, S., Hakimhashemi, A., Grundmann, N., Rees, F., Meyer, M., Algül, H., Müller-Nordhorn, J. (2022): Trends of colorectal cancer incidence according to age, anatomic site, and histological subgroup in Bavaria: A registry-based study. *Front Oncol.* 12, 904546.

Zhao, Z., Feng, Q., Yin, Z., Shuang, J., Bai, B., Yu, P., et al. (2017) Red and processed meat consumption and colorectal cancer risk: a systematic review and meta-analysis. *Oncotarget* 8 (47), 83306-83314.

Walter, V., Jansen, L., Ulrich, A., Roth, W., Bläker, H., Chang-Claude, J., et al. (2017): Alcohol consumption and survival of colorectal cancer patients: a population-based study from Germany. *Am J Clin Nutr* 103 (6), 1497-1506.

WCRF, World Cancer Research Fund/ AICR, American Institute for Cancer Research (2018): Diet, Nutrition, Physical Activity and Cancer: a Global Perspective. Continuous Update Project Expert Report 2018. https://www.wcrf.org/sites/default/files/Colorectal-cancer-report.pdf

WCRFI, World Cancer Research Fund International (2020): Continous Update Project – Colorectal Cancer Statistics. https://www.wcrf.org/dietandcancer/cancer-trends/colorectal-cancer-statistics

WHO, World Health Organization (2010): A healthy lifestyle - WHO recommendations. https://www.who.int/europe/news-room/fact-sheets/item/a-healthylifestyle---who-recommendations

WHO, World Health Organization. International Agency for Research on Cancer (2020): GLOBOCAN Cancer Today Data. https://gco.iarc.fr/today/home