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# Knowledge about dietary fibre and its health benefits: A cross-sectional survey of 2536 residents from across Croatia

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ABSTRACT

This cross-sectional study is aimed at identifying the level of understanding of the health benefits of dietary fibre in the prevention of disease, as well as the association between that understanding and fibre consumption in the Croatian population. We believe that nutritional knowledge is important for the consumption of healthy food which includes also a positive reflection on food habits and health. Only well-informed consumers can shop effectively for food rich in dietary fibre and thereby derive the health benefits that fibre can offer. We suppose the association between that understanding and fibre consumption in the Croatian population. However, this knowledge is not the only important determinant; food purchases are influenced by socioeconomic and demographic factors. Our hypothesis is that the level of knowledge about fibre and fibre consumption varies with age, gender, education level and urban or rural environment. It is our assumption that life styles, environmental conditions and education can affect the level of knowledge and perception about healthy eating habits. If this assumption is accurate, targeted education campaigns to educate and sensitise the population about fibre-rich foods and the health benefits of fibre is a priority. Public health programmes are urgently needed, particularly in rural areas, to sensitise the population to fulfill the recommended fibre intake, high-fibre food sources and the mechanisms by which fibre can help prevent disease.



## Background

Dietary fibre is defined as edible plant components, analogous to carbohydrates, that are resistant to digestion and absorption in the small intestine and that undergo complete or partial fermentation in the large intestine [1,2]. The chemical bonds in dietary fibre are not hydrolysed by human alimentary enzymes [1]. Sources of dietary fibre include plant products such as cereals, legumes, vegetables, fruit and seeds [1]. The recommended daily intake of dietary fibre depends on age, health requirements and the overall state of health [3]. Both the World Health Organisation (WHO) and Food and Agriculture Organisation recommend a daily intake of at least 25 g [1,2]. Croatian foodbased dietary guidelines recommend at least 400 g of fruit and vegetables (without potatoes) i.e. five or more servings per day in order to reach an adequate dietary fibre intake [4].

Preventive effects likely reflect the biological activity of dietary fibre, which shows anticancerous, antibacterial, anti-inflammatory, anti-oxidative and anti-apoptotic effects [5]. Studies have demonstrated the ability of dietary fibre to reduce cholesterol, triglycerides, systolic blood pressure, glycaemia and insulin sensitivity [6,7] and as a result, foods rich in dietary fibre can serve as non-pharmacological treatments [8]. Dietary fibre can help regulate body weight, influence immune function and contribute to diabetes control and prevent gastrointestinal disease, including gastroesophageal reflux, duodenal ulcus, irritable bowel syndrome, diverticulitis, constipation, and haemorrhoids [2,9].

People with more knowledge about food and its components, such as dietary fibre, may be able to make appropriate decisions about fibre consumption [10,11]. Only well-informed consumers can shop effectively for foods rich in dietary fibre and thereby derive the health benefits that fibre can offer [12]. Lack of

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awareness may be an important barrier to the development of promoting healthy food habits [13].

Despite the existing studies that confirm the associations between higher nutrition knowledge and dietary intake [12,14,15], some studies confirm the requirement for well-designed, high quality and contemporary research on the application of validated instruments to measure the nutritional knowledge and influence on dietary intake [11,12,15].

## Hypothesis

This study is motivated by the idea that a certain level of nutritional knowledge is important for healthy food consumption, including also a positive reflection on food habits and human health. In the present work, we wanted to examine the level of understanding of the health benefits of dietary fibre as well as the association between that understanding and fibre consumption in the Croatian population. Our hypothesis is that the level of knowledge about fibre and fibre consumption vary with age, gender, education level and urban or rural environment.

## Evaluation of the hypothesis

Nutrition knowledge has an important effect on food attitudes and behavior, as well as on health and disease prevention. Food behavior covers a multiplicity of distinct consumer behaviours including food choice, shopping, preparation and dietary intake [16]. This type of knowledge is best acquired by nutritional education. It is also crucial to look at how people interpret and use the information, as well as how it affects their behavior [16,17]. Moreover, people's perception and food types assessment are the most important mediators of the dietary intake [18].

Education and knowledge is significantly associated with healthy eating. Educated people are more likely to consume the recommended intake of healthy food, for example fruits and vegetables or food with less fat [16,17]. Knowledge about healthy food can significantly influence food purchases [15–17,19], indicating that the lack of such knowledge can pose a substantial obstacle to promoting healthy lifestyle. Despite that, knowledge about food impact on health is not of particular interest amongst the general population.

Even though essential nutritional knowledge is required, it is not likely to be sufficient for dietary changes. Literature indicates that knowledge is not the only important determinant; food purchases are also influenced by socioeconomic and demographic factors including age, gender, ethnicity, environment, household size and income [10,16].

Compared to the actual food intake, greater attention is given to certain other factors including taste, convenience, price and food security, as well as to different cultural, educational and economic factors [11]. What more, food availability also plays an important part on food behavior and food choices [20]. The positive correlation between knowledge and nutritional behavior is described in many studies [21–24].

It is a well known fact that specific knowledge about eating healthy and living a healthy lifestyle can prevent diseases, such as obesity, cardiovascular disease, diabetes and cancer [11]. Some nutritional components of food, like dietary fibre, also play an important role in the prevention of these diseases [1,2,25–27].

## Data analysis

This cross-sectional study involved a single survey of a convenience sample of the population covering all of the Croatian counties. The survey explored the respondents' knowledge about the importance of consuming dietary fibre and about the health effects of fibre. Various sociodemographic factors (age, gender, education level, urban or rural environment) were tested for their possible association with the level of knowledge about dietary fibre and fibre intake. We recruited respondents from the general population with the sole inclusion criteria that they be older than 18 years of age. We recruited through newspaper advertisements, booths in shopping centres and downtown areas and by word-of-mouth. We recruited this way with the intent of gathering a range of ages and education levels in both genders and in urban or rural living environments. Before filling out the survey, subjects were told about the purpose of the study; they were assured that the study was voluntary and that their responses would remain anonymous. Upon providing consent, subjects filled out the survey in individual cubicles to ensure privacy. A total of 2536 individuals were surveyed from October 2014 to March 2015. Ethical approval was granted by the Human Research Ethics Committee of the Zadar General Hospital. The entire data collection and analysis are in accordance with the ethical standards of the Declaration of Helsinki.

### *Measures*

The original questionnaire was written and validated in English by the CI&DETS Research Center of the Polytechnic Institute in Viseu, Portugal [28]. This English survey was translated into Croatian by two native speakers of Croatian with experience in public health and nutrition studies. No questions were modified, removed or added during the translation. The translated survey was examined by the creators of the English survey, who verified that the overall structure was unchanged. In this survey, respondents were asked about their consumption of dietary fibre and their awareness of concepts, definitions and health effects of dietary fibre. Items on the survey deal with demographic characteristics, fibre consumption (fruit, vegetables, whole grains), knowledge of fibre sources in foods, recommended daily fibre intake, and effects of fibre intake on the risk of certain diseases. The Croatian version of the questionnaire validation included a factor analysis (N = 2356). The level of dietary fibre knowledge was grouped into five factors explaining 55% of the variance; in the original questionnaire three factors included 76% of the variance, N = 182 [28]. Using Cronbach's alpha, the internal reliability of responses was acceptable, $\alpha = 0.75$; in the original questionnaire it was $\alpha = 0.90$ [28,29]. Responses to items were on a Likert scale from 1 to 5, with 1 indicating «completely disagree»; 2, «disagree»; 3, «neither disagree nor agree»; 4, «agree»; and 5, «completely agree». Responses to questions formulated in a negative way were scored using the same 5-point scale in reverse, so that higher scores always corresponded to greater knowledge. Responses were interpreted as reflecting familiarity about each statement (type of knowledge) according to the following 5-point scale: 1, «completely unfamiliar»; 2, «mostly unfamiliar»; 3, «uncertain»; 4, «somewhat familiar»; and 5, «completely familiar».

### *Statistical analysis*

The data was processed using SPSS 22.0 (IBM, Armonk, NY, USA). Results were analysed using descriptive statistics, primarily frequency distribution, measures of central tendency, dispersion and normal or asymmetric distribution. Since the data did not satisfy the conditions of normality based on the Kolmogorov-Smirnov test, differences in knowledge between men and women, between urban and rural residents, and between respondents of different educational backgrounds were assessed for significance using the Mann-Whitney *U* test (for two-variable comparisons) or the Kruskal-Wallis test (for comparisons of three or more variables). Possible associations among variables were explored using the

Spearman's rank correlation. Dispersion was reported in terms of the standard deviation, interquartile range, and quartile deviation coefficient. In all the analyses, the threshold of significance was defined as $P < 0.05$.

## Empirical data

The average age of all respondents was Mean = 33.9 years (SD 13.00, CI 33.43–34.44; range, 18–70); median age was 30.0 (interquartile range, 24), with 25% of the sample older than 46 years. The central 50% of respondents showed a relatively broad age distribution (0.35). The frequencies of respondents in different age groups is shown in Table 1. Most respondents were female (1704; 67.4%), while approximately half as many were male (826; 32.6%). Half of the respondents had a university education (1250; 49.4%), while a nearly equal number had completed only secondary school (1221; 48.3%), and only a handful primary school (54; 2.1%). [Five respondents (0.2%) did not answer the question about their education level.] More respondents were living in urban areas (1950; 77.1%) than in rural areas (558; 22.1%). Amongst the urban residents, slightly more than half had a university education (1042; 53.4%); amongst the rural residents, a similarly sized majority had completed only secondary school (326; 58.4%).

### *General knowledge about dietary fibre*

Median ($M_{dn}$) of the general knowledge of respondents about dietary fibre was 3.43 (interquartile range was 1), corresponding to an average of 68.6% on the Likert scale (where $M_{dn} = 5.00$ would correspond to 100%), extending from uncertainness to some familiarity. A quarter of the respondents showed complete or some familiarity 3.86, and another quarter showed uncertainty or unfamiliarity 3.14. Responses showed a fairly narrow distribution, based on the dispersion of the central 50% of the responses was 0.72 and the quartile deviation coefficient was 0.10. Results with this sample are likely to be precise estimates for the target population based on the small standard error for the central value (SEM = 0.01). An analysis of responses based on the demographic characteristics showed that knowledge about the presence of dietary fibre in plant products and about recommended daily fibre intake was greater amongst women than men, amongst the urban residents than the rural residents, and amongst those with a university education than those with lower education levels (Table 2). The respondents aged 46 to 55 years showed a significantly greater knowledge than other age groups.

### *Knowledge about health benefits of dietary fibre*

Median of the knowledge of respondents about the health benefits of dietary fibre was 3.50 (interquartile range 1), corresponding to 70.0% on the Likert scale, ranging from uncertainty to some familiarity. About a quarter of the respondents showed complete or partial familiarity (3.80), while another quarter showed uncertainty or unfamiliarity (3.10). The responses showed a fairly narrow distribution; dispersion of the central 50% of responses was 0.70 and the quartile deviation coefficient was 0.10. The results obtained from this sample are likely to be precise estimates for the target population (SEM = 0.01). The analysis of responses based on the demographic characteristics revealed that knowledge about the health benefits of dietary fibre was higher amongst women than men, amongst the urban residents than the rural residents, and amongst those with a university education than those with lower education levels (Table 3). The respondents aged 46–55 years showed a significantly greater knowledge about the health benefits of dietary fibre than other age groups, as it was also previously seen for the general knowledge about dietary fibre.

### *Association between general knowledge about dietary fibre and knowledge about its health benefits*

The level of general knowledge about dietary fibre in our sample correlated positively with the level of knowledge about its health benefits ($r_s = 0.24$). Joint variability between the two types of knowledge was 5.8% ($P < 0.001$). This variability, while statistically significant, is small, so we focused on the potential associations between the level of general knowledge and knowledge about the effects on specific diseases. Significant associations ($P < 0.001$) were observed in the case of constipation for 15%, ($r_s = 0.39$), bowel cancer for 14.0% ($r_s = 0.37$), chronic disease for 11.5% ($r_s = 0.34$), obesity for 6.2%, ($r_s = 0.25$) and elevated cholesterol for 4.3%, ($r_s = 0.21$).

### *Assocation between knowledge levels and consumption of fibre-containing foods*

We examined the possible relationships between knowledge about dietary fibre and weekly consumption of fruit, vegetables and cereals. The respondents consumed seven pieces of fruit and seven servings of vegetables each week ($M_{dn}$ 7.0), which translates to one piece of fruit and one serving of vegetables every day. The respondents consumed whole-grain food twice a week ($M_{dn}$ 2.0). One quarter of respondents consumed weekly at least seven servings of vegetables (upper quartile 8.5) and fruit (upper quartile 10.0), as well as more than two servings of whole grains (upper quartile 5.0). The consumption of vegetables was significantly greater amongst the respondents with a university education, while the consumption of fruit and whole grains was significantly greater amongst women than men, amongst the urban residents than the rural residents, and amongst the respondents with a university education (Table 4). The respondents aged 56–65 years consumed significantly more fruit than other age groups ($P = 0.015$), whereas consumption of cereals and vegetables did not vary significantly with age. The association between

**Table 1**
Distribution of the survey respondents from Croatia according to sociodemographic variables, N (%).

| Age group (years) | N (%) | Education | | | Gender | | Living environment | |
|---|---|---|---|---|---|---|---|---|
| | | PS | SS | UD | F | M | R | U |
| <25 | 1010 (39.9) | 15 (27.8) | 451 (36.9) | 543 (43.4) | 726 (42.6) | 284 (34.4) | 213 (38.2) | 794 (40.7) |
| 26–35 | 488 (19.3) | 3 (5.6) | 187 (15.3) | 296 (23.7) | 305 (17.9) | 183 (22.2) | 101 (18.1) | 384 (19.7) |
| 36–45 | 385 (15.2) | 11 (20.4) | 196 (16.1) | 176 14.1% | 260 (15.3) | 125 (15.1) | 92 (16.5) | 290 (14.9) |
| 46–55 | 480 (19.0) | 14 (25.9) | 294 (24.1) | 172 (13.8) | 316 (18.5) | 164 (19.9) | 114 (20.4) | 360 (18.5) |
| 56–65 | 143 (5.7) | 9 (16.7) | 77 (6.3) | 57 (4.6) | 80 (4.7) | 63 (7.6) | 31 (5.6) | 107 (5.5) |
| >66 | 24 (0.9) | 2 (3.7) | 16 (1.3) | 6 (0.5) | 17 (1.0) | 7 (0.8) | 7 (1.3) | 15 (0.8) |
| Total | 2530 (100.0) | 54 (100.0) | 1221 (100.0) | 1250 (100.0) | 1704 (100.0) | 826 (100.0) | 558 (100.0) | 1950 (100.0) |

PS = primary school; SS = secondary school; UD = university degree; F = female; M = male;R = rural; U = urban.

**Table 2**
Sociodemographic characteristics and general knowledge about DF in a sample of Croatian residents (N = 2536) by parameter estimates mean rank of the Mann-Whitney *U* test for gender and living environment or mean rank of the Kruskal-Wallis test for education and age.

| Variable | GK 1 | GK 2 | GK 3 | GK 4 | GK 5 | GK 6 | GK 7 |
|---|---|---|---|---|---|---|---|
| *Gender* | | | | | | | |
| Female | 1284.29 | 1285.24 | 1310.12 | 1297.02 | 1300.8 | 1285.54 | 1295.29 |
| Male | 1211.53 | 1183.280 | 1144.81 | 1180.32 | 1180.65 | 1188.87 | 1170.37 |
| $p^*$ | 0.016 | 0.001 | <0.001 | <0.001 | <0.001 | 0.001 | <0.001 |
| *Living environment* | | | | | | | |
| Rural | 1195.63 | 1165.07 | 1165.41 | 1163.44 | 1179.90 | 1259.08 | 1217.75 |
| Urban | 1265.56 | 1263.94 | 1268.42 | 1272.13 | 1271.28 | 1240.35 | 1251.51 |
| $p^*$ | 0.039 | 0.003 | 0.002 | 0.001 | 0.004 | 0.569 | 0.287 |
| *Education* | | | | | | | |
| Primary school | 1086.94 | 1044.84 | 1167.80 | 1113.64 | 1150.37 | 1328.54 | 1155.22 |
| Secondary school | 1234.84 | 1229.44 | 1158.95 | 1208.15 | 1205.95 | 1226.66 | 1236.13 |
| University degree | 1287.95 | 1278.04 | 1349.50 | 1309.73 | 1315.30 | 1273.50 | 1271.57 |
| $p^*$ | 0.035 | 0.022 | <0.001 | 0.001 | <0.001 | 0.170 | 0.231 |
| *Age (years)* | | | | | | | |
| <25 | 1184.06 | 1177.94 | 1294.35 | 1256.98 | 1277.34 | 1288.15 | 1282.52 |
| 26–35 | 1226.35 | 1229.29 | 1240.76 | 1231.44 | 1184.49 | 1216.69 | 1210.45 |
| 36–45 | 1332.17 | 1362.42 | 1219.44 | 1268.11 | 1238.30 | 1207.80 | 1221.51 |
| 46–55 | 1392.02 | 1320.06 | 1213.04 | 1281.13 | 1313.21 | 1250.93 | 1265.97 |
| 56–65 | 1318.73 | 1333.40 | 1241.48 | 1278.20 | 1277.26 | 1269.77 | 1258.11 |
| >66 | 1062.15 | 1242.24 | 1503.95 | 1200.54 | 1398.31 | 1272.00 | 1241.37 |
| $p^*$ | <0.001 | <0.001 | 0.114 | 0.906 | 0.045 | 0.332 | 0.414 |

Parameter estimates in each column that share mean rank of the Mann-Whitney *U* test for gender and living environment or share mean rank of the Kruskal-Wallis test for education and age. DF = dietary fiber; GK = General knowledge; GK 1 = DF comes only from vegetables; GK 2 = Animal foods such as meat, eggs and milk products do not contain DF (unless it is added); GK 3 = Whole-grain foods (pasta, rice, bread, cereal) contain less DF than non-whole-grain foods; GK 4 = Unpeeled fruits contain less DF than peeled ones; GK 5 = Legumes (e.g. peas, beans), cereals and fruits are very rich in DF, GK 6 = The daily intake of DF recommended by the WHO is 25 g; GK 7 = DF is classified as soluble or insoluble.

* $p < 0.05$.

**Table 3**
Sociodemographic characteristics and knowledge about the health benefits of DF in a sample of Croatian residents (N = 2536) by parameter estimates mean rank of the Mann-Whitney *U* test for gender and living environment or mean rank of the Kruskal-Wallis test for education and age.

| Variable | HK 1 | HK 2 | HK 3 | HK 4 | HK 5 | HK 6 | HK 7 | HK 8 | HK 9 | HK 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| *Gender* | | | | | | | | | | |
| Female | 1281.75 | 1266.71 | 1292.51 | 1296.48 | 1299.89 | 1282.79 | 1315.88 | 1262.06 | 1290.86 | 1282.96 |
| Male | 1227.44 | 1253.85 | 1183.69 | 1179.03 | 1177.94 | 1204.15 | 1131.51 | 1249.66 | 1201.1 | 1217.35 |
| $p^*$ | 0.050 | 0.657 | <0.001 | <0.001 | <0.001 | 0.006 | <0.001 | 0.668 | 0.002 | 0.024 |
| *Living environment* | | | | | | | | | | |
| Rural | 1184.38 | 1238.16 | 1212.00 | 1163.02 | 1183.44 | 1251.29 | 1173.56 | 1282.62 | 1242.99 | 1224.96 |
| Urban | 1272.67 | 1255.32 | 1256.32 | 1271.05 | 1267.78 | 1245.13 | 1264.82 | 1236.77 | 1252.65 | 1257.82 |
| $p^*$ | 0.004 | 0.598 | 0.166 | 0.001 | 0.009 | 0.847 | 0.004 | 0.157 | 0.771 | 0.314 |
| *Education* | | | | | | | | | | |
| Primary school | 1263.34 | 1338.77 | 1292.60 | 998.81 | 1123.52 | 1240.99 | 1021.82 | 1303.89 | 1303.11 | 1158.95 |
| Secondary school | 1192.13 | 1237.00 | 1226.35 | 1198.68 | 1214.31 | 1253.35 | 1190.72 | 1296.89 | 1296.19 | 1234.94 |
| University degree | 1329.24 | 1279.02 | 1280.23 | 1321.80 | 1305.46 | 1256.20 | 1323.01 | 1212.94 | 1220.77 | 1286.86 |
| $p^*$ | <0.001 | 0.214 | 0.124 | <0.001 | 0.001 | 0.983 | <0.001 | 0.008 | 0.024 | 0.095 |
| *Age (years)* | | | | | | | | | | |
| <25 | 1275.86 | 1208.06 | 1215.15 | 1177.60 | 1223.86 | 1203.74 | 1234.24 | 1243.98 | 1280.55 | 1209.11 |
| 26–35 | 1274.07 | 1308.87 | 1248.94 | 1216.32 | 1226.80 | 1253.47 | 1211.62 | 1240.03 | 1249.71 | 1279.68 |
| 36–45 | 1238.70 | 1266.79 | 1266.93 | 1321.18 | 1292.07 | 1309.21 | 1264.50 | 1224.56 | 1267.71 | 1285.36 |
| 46–55 | 1275.32 | 1335.50 | 1351.16 | 1404.95 | 1344.42 | 1311.77 | 1322.54 | 1308.45 | 1236.95 | 1328.39 |
| 56–65 | 1204.67 | 1264.19 | 1251.29 | 1307.34 | 1264.72 | 1307.62 | 1290.56 | 1333.61 | 1248.76 | 1288.64 |
| >66 | 1094.56 | 1082.81 | 1181.65 | 1269.83 | 1236.83 | 1368.88 | 1376.57 | 1289.83 | 1165.65 | 1213.00 |
| $p^*$ | 0.553 | 0.007 | 0.017 | <0.001 | 0.030 | 0.020 | 0.110 | 0.295 | 0.846 | 0.041 |

Parameter estimates in each collum that share mean rank of the Mann-Whitney *U* test for gender and living environment or share mean rank of the Kruskal-Wallis test for education and age. DF – dietary fibre; HK = health knowledge; HK 1 = DF prevent and treat diseases; HK 2 = DF prevent and treat cardiovascular diseases; HK 3 = DF prevent and treat elevated cholesterol; HK 4 = DF prevent and treat bowel cancer; HK 5 = DF prevent and treat obesity; HK 6 = DF prevent and treat breast cancer; HK 7 = DF prevent and treat constipation; HK 8 = DF prevent and treat vision problem; HK 9 = DF prevent and treat deficit vitamins and minerals; HK 10 = DF prevent and treat diabetes.

* $p < 0.05$.

knowledge about dietary fibre and the consumption of foods rich in dietary fibre was weak (2.7%, $r_s = 0.17$, $P < 0.001$).

## Consequences of the hypothesis and discussion

This cross-sectional survey of the general population in Croatia indicates that substantial levels of uncertainty and incomplete knowledge exist about the definition and characteristics of dietary fibre, what foods contain fibre, and how dietary fibre consumption can benefit your health. Results of this study suggest that the level of general knowledge about fibre among the Croatian population is insufficient to facilitate greater knowledge of health benefits.

In this research we found evidence linking fibre consumption to general knowledge of dietary fibre and knowledge of dietary fibre's

**Table 4**
Consumption of DF stratified by sociodemographic characteristics by parameter estimates mean the rank of the Mann-Whitney *U* test for gender and living environment or mean rank of the Kruskal-Wallis test for education and age.

| Variable | Salads | Fruit | Whole Cereals |
|---|---|---|---|
| *Gender* | | | |
| Female | 1283.65 | 1297.84 | 1329.33 |
| Male | 1214.18 | 1171.36 | 1122.68 |
| $p^*$ | 0.023 | <0.001 | <0.001 |
| *Living environment* | | | |
| Rural | 1236.11 | 1178.15 | 1115.42 |
| Urban | 1255.27 | 1265.45 | 1289.94 |
| $p^*$ | 0.965 | 0.029 | <0.001 |
| *Education* | | | |
| Primary school | 1072.59 | 1136.05 | 1084.56 |
| Secondary school | 1174.44 | 1197.42 | 1197.81 |
| University degree | 1348.18 | 1314.49 | 1327.18 |
| $p^*$ | <0.001 | <0.001 | <0.001 |
| *Age (years)* | | | |
| <25 | 1307,52 | 1254,04 | 1258,87 |
| 26–35 | 1257,72 | 1235,90 | 1261,08 |
| 36–45 | 1210,26 | 1161,98 | 1240,70 |
| 46–55 | 1225,05 | 1331,91 | 1249,54 |
| 56–65 | 1210,64 | 1342,01 | 1331,25 |
| >66 | 1204,85 | 1289,46 | 1590,56 |
| $p^*$ | 0.145 | 0.015 | 0.234 |

$p < 0.05$.
Parameter estimates in each collum share is the mean rank of the Mann-Whitney *U* test for gender and living environment or the mean rank of the Kruskal-Wallis test for education and age.

health effects, although the associations were weak. We observed a positive correlation between level of general knowledge about dietary fibre and level of knowledge about the health benefits of fibre, suggesting that the two types of knowledge reinforce each other.

Our results identify several sociodemographic factors associated with greater knowledge of dietary fibre, including female gender, middle age, urban environment and high level education. A study in England also showed that female gender and middle age individuals had better knowledge, and that nutrition knowledge tended to be better with higher levels of education [11]. In Swiss consumers higher knowledge was associated with the female gender, younger age, higher education and nutrition-related qualifications [30].

We found in our Croatian cohort that women, urban residents and individuals aged 56–65 years were more likely to consume more servings of fruit, vegetables and whole cereals per day. Some studies have confirmed that women [14], especially more educated ones as well as people older than 65 years, are more likely to consume at least five servings of fruit and vegetables a day [31]. Unfortunately we did not collect anthropometric data or self-report data on self-image and therefore, future work should be examined directly as to how these factors may influence dietary fibre consumption. One would expect that, as people reach middle age, they become more aware of diseases related to diet [10]. Greater knowledge about dietary fibre amongst elderly individuals may reflect the fact that they are more likely than their younger counterparts to have developed the diseases that fibre intake has been reported to mitigate or prevent [10,32]. Future studies should address what factors make older individuals more knowledgeable about fibre composition in foods and the health benefits of fibre. Similarly, a study in Norway showed that older women consumed more healthier food than younger women [33]. This indicates that high nutrition knowledge in women and the perception about health in middle aged and the elderly people, could be associated with healthy eating habits [10]. Greater knowledge about dietary fibre amongst women may reflect their greater interest in healthy eating because of its impact on body weight and therefore self-image [34–37].

Our respondents were highly uncertain about the ability of high fibre intake to reduce postprandial response to glucose, hyperinsulinemia and blood glucose levels, as well as improve lipid levels in the blood. For these reasons, most diabetes societies recommend high fibre intake. Lack of knowledge about these diabetes-specific health benefits of dietary fibre may pose a problem for patients in Croatia if it makes them less likely to consume high-fibre foods, as reported in a sample of Polish patients with diabetes [38].

A relatively small proportion of our respondents felt confident that consuming larger amounts of dietary fibre can significantly reduce the risk of developing coronary heart disease, brain stroke, hypertension, diabetes, obesity and certain gastrointestinal problems that occur more often in older people [1,6,7,9,25–27]. These health benefits likely reflect the ability of dietary fibre to alter the viscosity of intestinal contents, nutrient absorption, intestinal residence time, production of short-chain fatty acids and secretion of intestinal hormones [6].

Our observation of greater knowledge about dietary fibre amongst respondents with a university education may reflect that they received more education about keeping a healthy diet in school. Unfortunately the data collected in this study do not allow us to support or refute that possibility, which depends on the level and specialisation of an individual's education, as well as the individual's interests. Although in products produced in rural environments such as fruits and vegetables, our results revealed the lower consumption of dietary fibre in rural compared to urban communities, which may be associated with fewer stores that offer a wide selection of healthy food [31]. Nevertheless, our data clearly supports the idea that higher education in an urban environment is associated with a higher degree of knowledge about dietary fibre. This may in part reflect the generally higher level of development in urban areas, including more numerous stores offering health food products [39]; this exposure may increase interest in fibre-containing foods. For example, information and sensitisation programmes in Croatia should focus on the types of general knowledge covered in this survey, particularly on knowledge about daily fibre intake and sources of high fibre. These efforts should be directed especially at individuals in rural areas. In addition, existing public health programmes aimed at reducing the incidence of diseases mentioned on the survey in this study should emphasise the potential health benefits of adequate fibre intake.

The need for such campaigns in the Croatian public is reflected in our finding that self-report consumption of dietary fibre is below the recommended amounts, as was reported for Portugal [40], which those authors attributed in part to limited knowledge about dietary fibre. Such campaigns may need to target men in particular, since in our study as well as several others, women are more knowledgeable about dietary fibre, though the studies disagree about whether other factors such as education level and rural/urban setting are also involved.

The strengths of the present study are relatively large and the detailed breakdown of types of knowledge about dietary fibre, both general and health-related. At the same time, our results should be interpreted carefully in light of some limitations. Slightly lower, but respectable internal reliability of the Croatian version questionnaire, contributed to the lower reliability of general knowledge. It can be assumed that the rejection of the particles in these scales provide greater reliability of the instrument. In further research, check of other measurement questionnaire characteristics, such as the specificity and sensitivity should be done. We did not collect anthropometric data or 24-h dietary recall about dietary fibre consumption. The survey asked about the attitudes and intentions about consuming dietary fibre, but it did not quantify actual daily intake or actual food buying behavior.

*Implication for further research and practice*

The results of our study confirm that several demographic factors (female gender, urban environment, and especially university education) were associated with both greater knowledge of dietary fibre and greater consumption. Future studies should aim to correlate knowledge about dietary fibre with actual fibre consumption, which would substantially improve our understanding of public behavior, allowing the improvement of public health programmes. Our survey data may help to inform public health campaigns aimed at promoting consumption of foods rich in dietary fibre. This detailed analysis of levels of general and health-related knowledge about dietary fibre may help design effective public health programmes in Croatia and potentially other countries. Thus, targeted education campaigns to educate and sensitise the population about fibre-rich foods and the health benefits of fibre may increase the consumption of such foods. Public health programmes are urgently needed, particularly in rural areas, to sensitise the population to recommended fibre intake, high-fibre food sources and the mechanisms by which fibre can help prevent disease.

## Ethical standards disclosure

Ethical approval was granted by the Human Research Ethics Committee of General Hospital Zadar (No. 01-178-3/15). The research was conforms to the provisions of the World Medical Association (2000) Declaration of Helsinki: ethical considerations for medical research involving human subjects.

## Conflict of interest statement

All the authors declare that they have no conflict of interest.

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