NUTRITION AS A SCIENTIFIC FIELD IN CROATIA: BIBLIOMETRIC ANALYSIS OF THE PERIOD 2010 – 2020

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Summary

The scientific community's interest in nutrition, i.e., the interaction of human and food consumption, is constantly rising worldwide and in Croatia. The published research results deepen our understanding of the processes involved in the interplay between food consumption and health, as well as different diseases and malfunctions in the human body. This research provides insight into scientific themes and focuses on nutrition research in Croatia.

The study aims to provide an overview of the development of nutrition as a scientific field in Croatia from 2010 to 2020 using descriptive bibliometric analysis and science mapping. The analysis was made on a sample of 1173 articles indexed in the Web of Science Core Collection (WoS CC) database.

In the analyzed period, nutrition and its impact on people's health, especially on children's health, are the focus of Croatian scientists' research. Furthermore, it can be concluded that the same research trends continue in future research.

Keywords: nutrition, Croatia, bibliometric analysis, science mapping

Introduction

Nutrition or food science is a scientific discipline, with intensive growth in the world in the last 150 years. Kenneth J. Carpenter reviewed the development of nutrition in his articles, clearly showing that scientists have recognised the importance of nutrition both for the individuals and for society (Carpenter, 2003a; 2003b; 2003c; 2003d). Understanding food properties and eating habits are fundamental because they are the basis for nutritional improvements which directly influence human health (Ulfa et al., 2022). National legislation regarding food (National Gazette 81/13, 14/14, 30/15, 115/18), food hygiene and microbiological criteria for food (National Gazette 81/13, 115/18) in Croatia was adopted in 2013. According to the Agency for Science and Higher Education and Database of Study Programmes (MOZVAG), there are different nutrition-related studies in Croatia (Table 1). Faculty of Food Technology and Biotechnology, University of Zagreb offers under- and graduate programs in Nutrition, as well as postgraduate university PhD study programs in Biotechnology and Bioprocess Engineering, Food Technology and Nutrition. In contrast, Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek (PTFOS) offers postgraduate university PhD programs in Food Technology and Nutrition, in addition to postgraduate specialist study in Nutrition (MOZVAG Database – selection of scientific field 2022). Food Science and Nutrition graduate study is also offered at PTFOS, but this programme is categorized in the field food technology in the MOZVAG database (MOZVAG Database – food technology 2022).

Table 1. Study programs in the scientific field of Nutrition, grouped by degree holder (source: MOZVAG Database – selection of scientific field, 2022)

Title of the study programme	Holder*	Type of study	Duration	Qualification
Nutrition	PBFZG	undergraduate university study	3	EQF6 Bachelor
Nutrition	PBFZG	Graduate university study	2	EQF7 Master
Biotechnology and Bioprocess Engineering, Food Technology and Nutrition	PBFZG	Postgraduate university (PhD) study	3	EQF8 PhD
Food Technology and Nutrition	PTFOS	Postgraduate university (PhD) study	3	EQF8 PhD
Nutrition	PTFOS	Postgraduate university (specialist) study	1	specialist master, university specialist

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In his model of knowledge accumulation, Price asserted in 1963 that scientific progress is achieved by the researchers with local, national and international characteristics who study scientific themes by relying on work of other scientists (Price, 1963). Bibliometrics is a method of quantitative study of the presentation of knowledge through the investigation of the properties and behaviour of bibliographic records, independent of the content of scientific literature ("Bibliometrija", 2021). Bibliometric indicators have proven to be useful tools for evaluating research results, provided that they have a sufficient level of sophistication, that their pitfalls are taken into account, and that they are used in combination with other, more qualitative knowledge about the units to be evaluated (Moed, 2000). Scholarly communication is constantly growing, making being up-to-date with published works very hard in any scientific field, including nutrition. Consequently, the number of systematic reviews of the literature demonstrating dynamics of the scientific development in particular scientific fields through the establishment of knowledge bases, research focal points, and research fronts over a time period and indicating the current themes in scientific field is also increasing. This is also the case in the realm of nutrition (Figure 1), where a significant increase after 2018 may be observed.
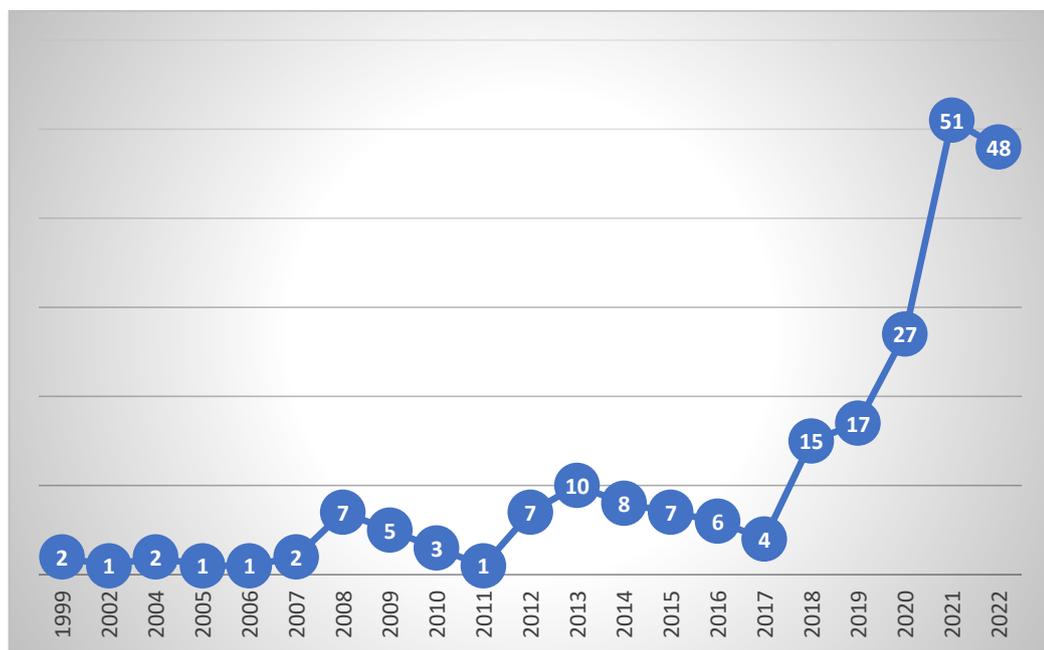

Figure 1. The number of published systematic reviews in the field of nutrition (*source: Web of Science Core Collection*)

Descriptive research is research that studies the number of publications in certain fields in a way that compares research patterns in the analysed period, either for a particular scientific field, institution or country (Pehar, 2010). In numerous nutrition-related literature reviews, descriptive bibliometric analysis has already been conducted. Smith (1999) identified the leading journals in dietetics and established the indexing scope. van Raan and van Leeuwen (2002) reviewed the research undertaken at the Institute for research of food and nutrition in Netherlands, as well as its influence and interdisciplinarity, along with methodological discussion of bibliometric indicators applied in the analysis. There have also been reviews of the scientific activities concerning flavonoids in food, the influence of various plants as suitable food supplements, and phytochemicals and their effects on human body (Perez-Vizcaino and Fraga, 2018; Chhicara et al., 2021; Venthodika et al., 2021). Different authors have also published systematic literature reviews of different commercially available foods and food components utilizing descriptive bibliometric methods and science mapping. Kamdem et al. (2019) provided a bibliometric overview of the most significant scientific achievements published in the journal Food Chemistry since its first issue (1976). Skaf et al. (2020) conducted a literature review on food safety using social networks analysis. Shen, Wei and Sheng (2021) determined the current characteristics and key points of food safety management, envisaging future research trends. Sendhil et al. (2022) provided bibliometric trends of

the literature addresing consumer preferences towards genetically modified food, whereas Young et al. (2019) reviewed literature on resveratrol. Mbao et al. (2022) analysed trends in the usage of diatoms in water quality monitoring and bioassessment in Africa.

This study aims to examine the field of nutrition in the Republic of Croatia from 2010 to 2020 through descriptive bibliometric analysis and science mapping.

Material and methods

Different bibliometric determinants targeting measurement and evaluation of activities and influences of authors, journals and institutions were included in the descriptive bibliometric analysis, and scientific mapping was used to visualize the dynamics of the development of scientific research in the field of nutrition in Croatia. The scientific collaboration was analysed using affiliations stated in the articles (Supplementary material 1), where articles with only Croatian affiliations were separated from those with affiliations in other countries. These provided answers to questions regarding the formation of knowledge bases, the evolution of research focal points and research fronts across time, and potential future research directions. The research is designed to encompass bibliometric elements of nutrition research and present them using the different visualisation methods and techniques.

Data source and literature search strategy

The Web of Science Core Collection (WoS CC) citation indexes were used as a starting point for identifying and acquiring relevant scientific publications on nutrition published by authors with Croatian affiliations. The search was conducted using the terms "nutrition" in *All fields* and "Croatia" in *Address*, with the Boolean operator AND connecting the terms. This search strategy resulted in a total of 2522 publications, which were later limited to the period 2010 – 2020 (1620 results). Abstracts (97), proceedings papers (50), editorials (28), book chapters (28), corrections (16), letters (16), notes (4), publications with expression of concerns (1), retracted publication (1) were excluded from the sample because of their minor relevance for the purpose of this study. In the last round, 1171 journal articles and 210 reviews were selected.

Articles on animal feed, plant nutrition, history, medical research of influence of medicaments on human body, medicinal care, aquaculture, food industry by-products, genetic analyses, morphometry (non-invasive method for determination of size, proportion and composition of human body) were excluded from the subsequent analysis based on an additional title, keyword and abstract screening (208). As a consequence, 1173 articles were selected as a representative sample for bibliometric analysis.

Bibliometrics analysis and science mapping

Data from WoS CC were exported into spreadsheet and tabular formats for further bibliometric analysis and scientific mapping. Visualisation mapping was performed using CiteSpace II. The algorithm of spectral grouping (tf*idf), log-likelihood ratio tests, and mutual information were used to classify the data in CiteSpace II. Clusters were assigned based on the size of the data (the largest is always #0). Modularity and pondered mean silhouette are metrics that indicate the quality of grouping data into clusters and are important parameters for data analysis and interpretation. The higher the modularity and silhouette, the better the results (Chen and Song, 2019). According to Chen, Ibekwe-SanJuan and Hou (2010), focal points of research and research trends can be revealed by citing different types of nodes, such as keywords, authors, institutions, countries and references, as well as concurrent phenomena.

Results and discussion

The language of published articles

The research includes articles and reviews published in scholarly journals. The majority of the 1173 articles are written in English (96.5%), with 29 articles (3%) written in Croatian and three articles (0.29%) in German, one in Czech and one in Italian (Figure 2).
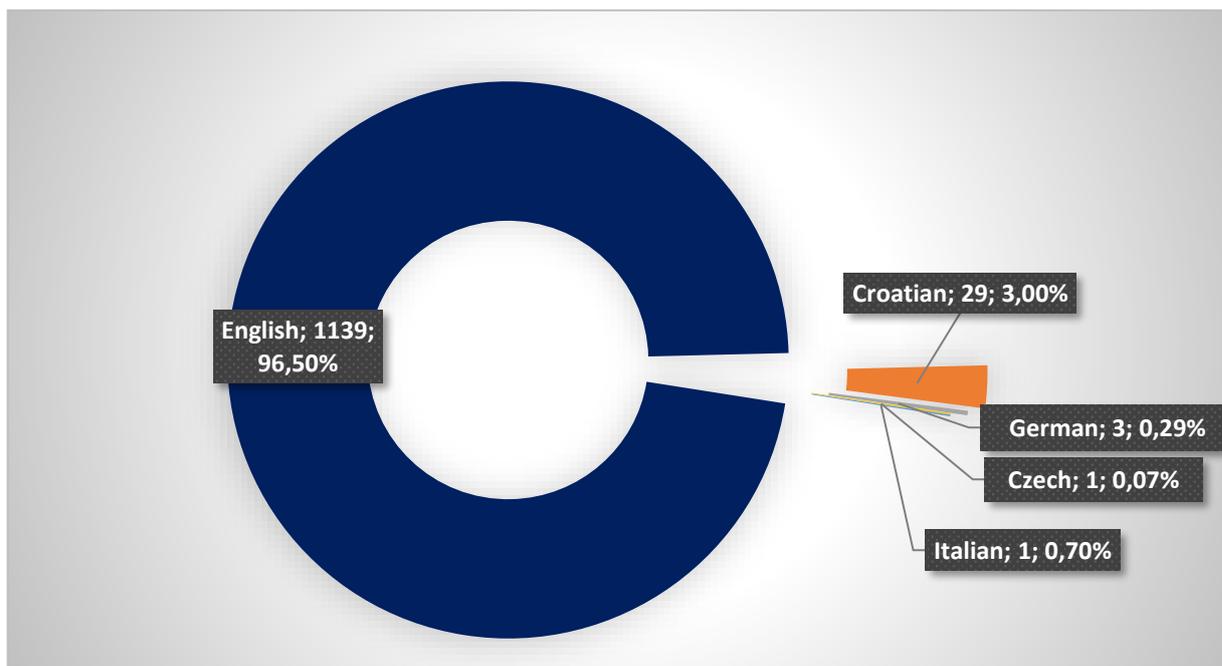
Figure 2. Language of articles published by Croatian scientists in WoS CC-indexed journals between 2010 and 2020

Annual growth of nutrition-related journal articles in Croatia

The analysis of the number of published articles indexed in WoS CC indicates a steady increase in nutrition research by Croatian scientists. During the period covered by this study, the number of publications tripled (Figure 3), suggesting that Croatian researchers are following the global trend of increasing interest in this scientific topic. Since 2017, the number of articles published in nutrition has increased significantly.
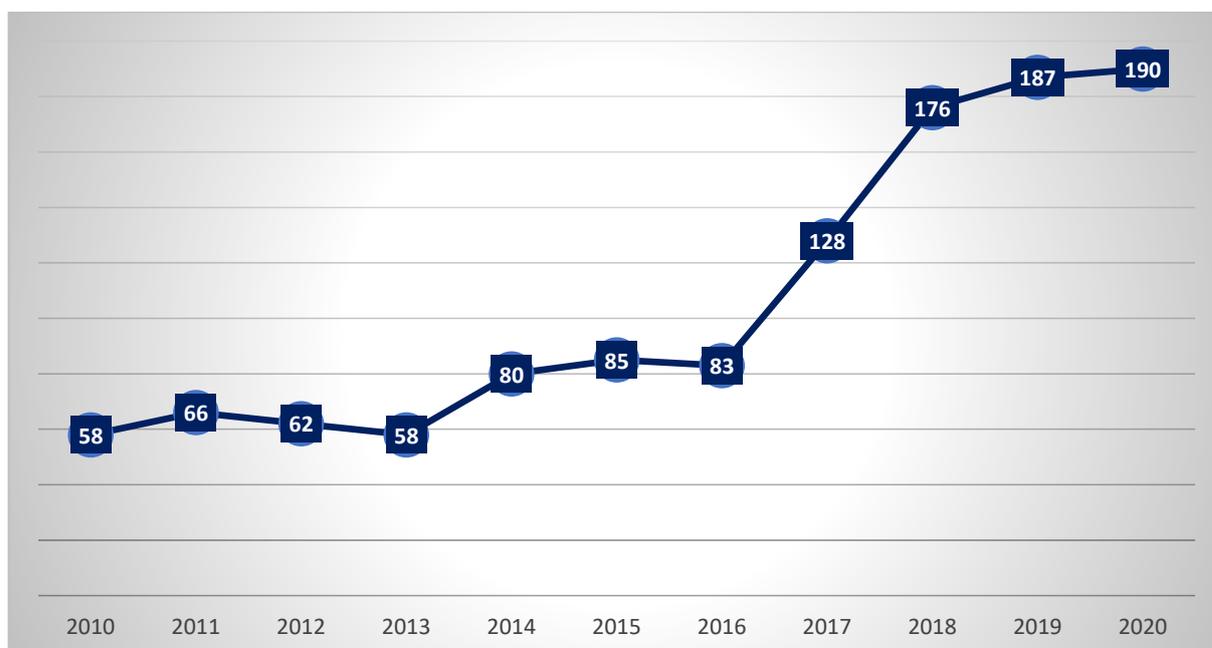

Figure 3. The number of scientific articles published by Croatian authors and indexed in WoS CC

Most important source journals

The bibliometric analysis of the journals in which Croatian authors publish nutrition-related articles revealed that the top ten articles are: *Journal of Pediatric Gastroenterology and Nutrition*, *Clinical Nutrition*, *Nature Genetics*, *Collegium Antropologicum*, *Nutrients* and *Journal of Food and Nutrition Research* (Table 2). According to Journal Citation Reports, impact factor (IF) of these journals in 2021 ranged from 0.609 to 202.731. Moreover, *Lancet*, *Food Chemistry*, *Nutrients*, *Clinical Nutrition* and *Nature Journal of Pediatric Gastroenterology and Nutrition* had very high citation counts (Figure 4).

Table 2. Top ten journals ranked by the number of articles (co)authored by Croatian researchers indexed in WoS CC, in the scientific field nutrition in the period 2010 – 2020

| Journal	Number of articles published by Croatian authors	WoS Category	IF 2021.	Quartile
Journal of Pediatric Gastroenterology and Nutrition	56	Pediatrics – SCIE; Nutrition & Dietetics – SCIE; Gastroenterology & Hepatology - SCIE	3,355	Q3; Q3; Q2
Clinical Nutrition	37	Nutrition & Dietetics – SCIE	7,643	Q1
Nature Genetics	33	Genetics & Heredity - SCIE	41,376	Q1
Collegium Antropologicum	26	Anthropology - SSCI	0,609	Q3
Nutrients	24	Nutrition & Dietetics – SCIE	6,706	Q1
Journal of Food and Nutrition Research	23	Food Science & Technology - SCIE	1,138	Q4
Lancet	19	Medicine, General & Internal - SCIE	202,731	Q1
Food Chemistry	16	Nutrition & Dietetics – SCIE; Chemistry, Applied – SCI; Food Science & Technology - SCIE	9,231	Q1; Q1; Q1
Nature	14	Multidisciplinary Sciences - SCIE	69,504	Q1
Acta Clinica Croatica	13	Medicine, General & Internal - SCIE	0,932	Q4
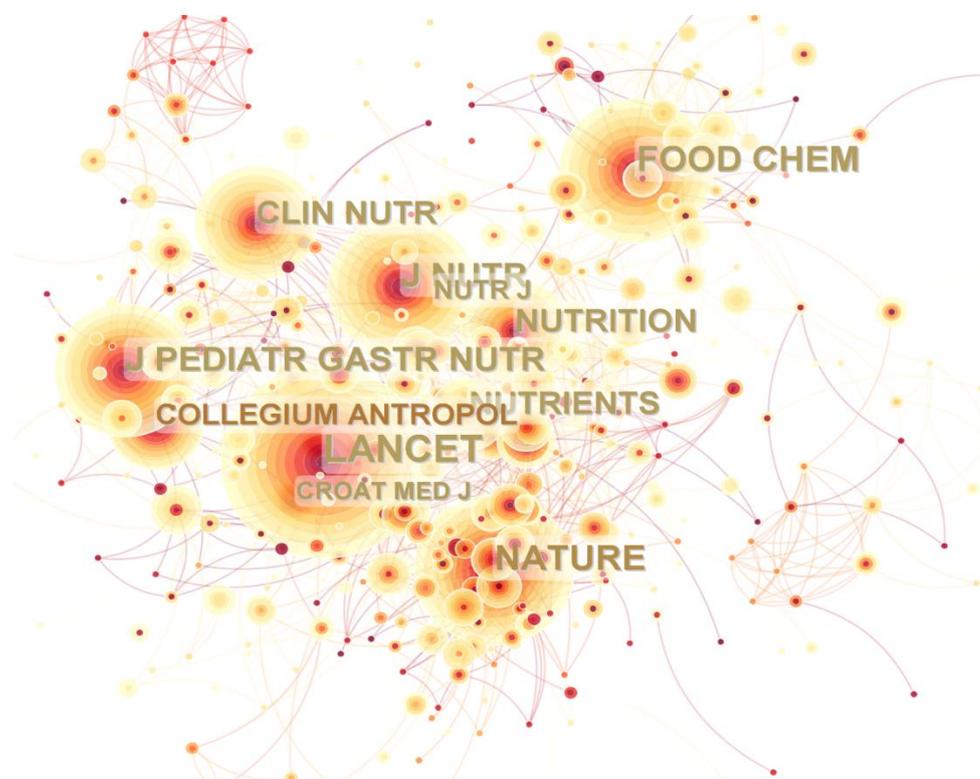
Figure 4. Journals indexed in WoS CC, in which Croatian authors published articles in the scientific field nutrition in the period 2010 - 2020, with more than 150 citations

Publication models

In the analysed sample, 46% of articles are published based on the traditional subscription or pay-per-view model, where there is typically no publication fee, although some publishers require payment of author processing charges (Baffy et al., 2020), and 54% of the articles are published using the open access model (gold, diamond, green) (Figure 5).
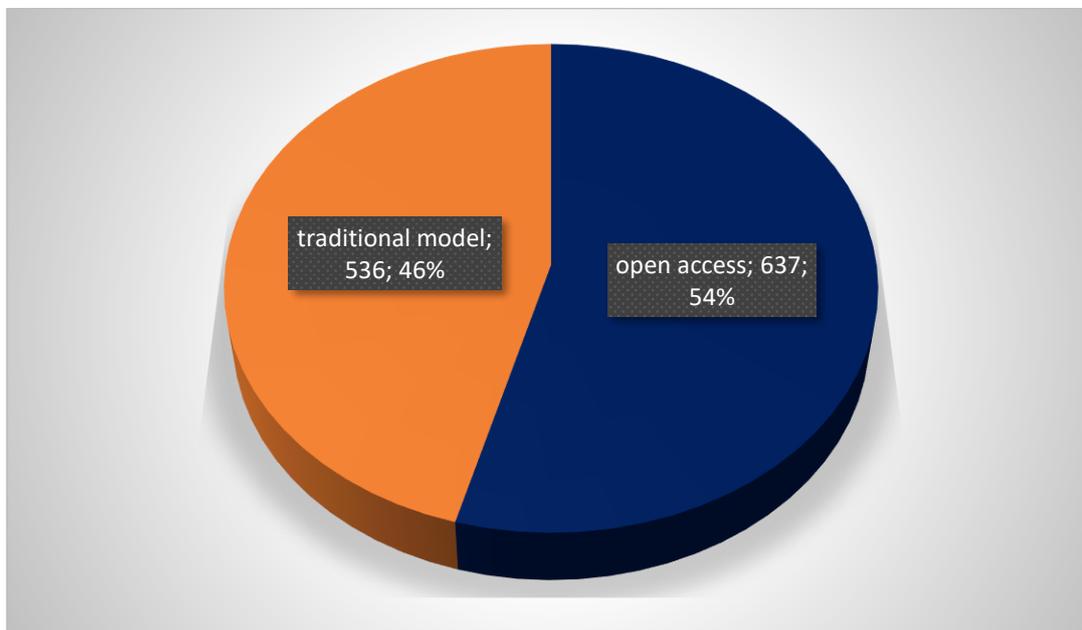

Figure 5. Publication model for articles written by Croatian authors, published in the scientific field of nutrition between 2010 and 2020

Since 2017 (Figure 6), the number of open access articles has been increased, which correlates with total publication activity of Croatian scientist in the field (Figure 3).
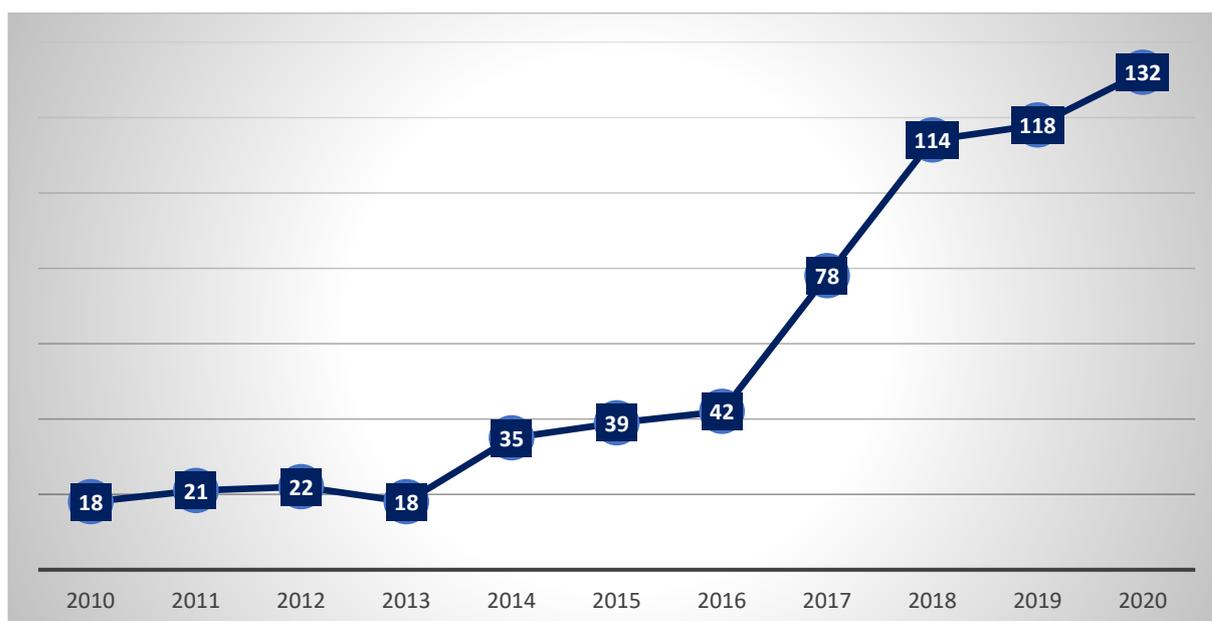

Figure 6. Annual growth in the number of open access articles (co)authored by Croatian authors in the scientific field nutrition between 2010 and 2020

WoS Research Areas

Figure 7 depicts WoS research areas with ten or more nutrion-related papers published by Croatian scientists. This elucidates the interdisciplinary nature of the research field. The majority of articles is categorized under Nutrition Dietetics (276) and Food Technology (219), but the importance of nutrition in other scientific disciplines, such as medicine, biochemistry and molecular biology, analytical chemistry etc. is also identified.
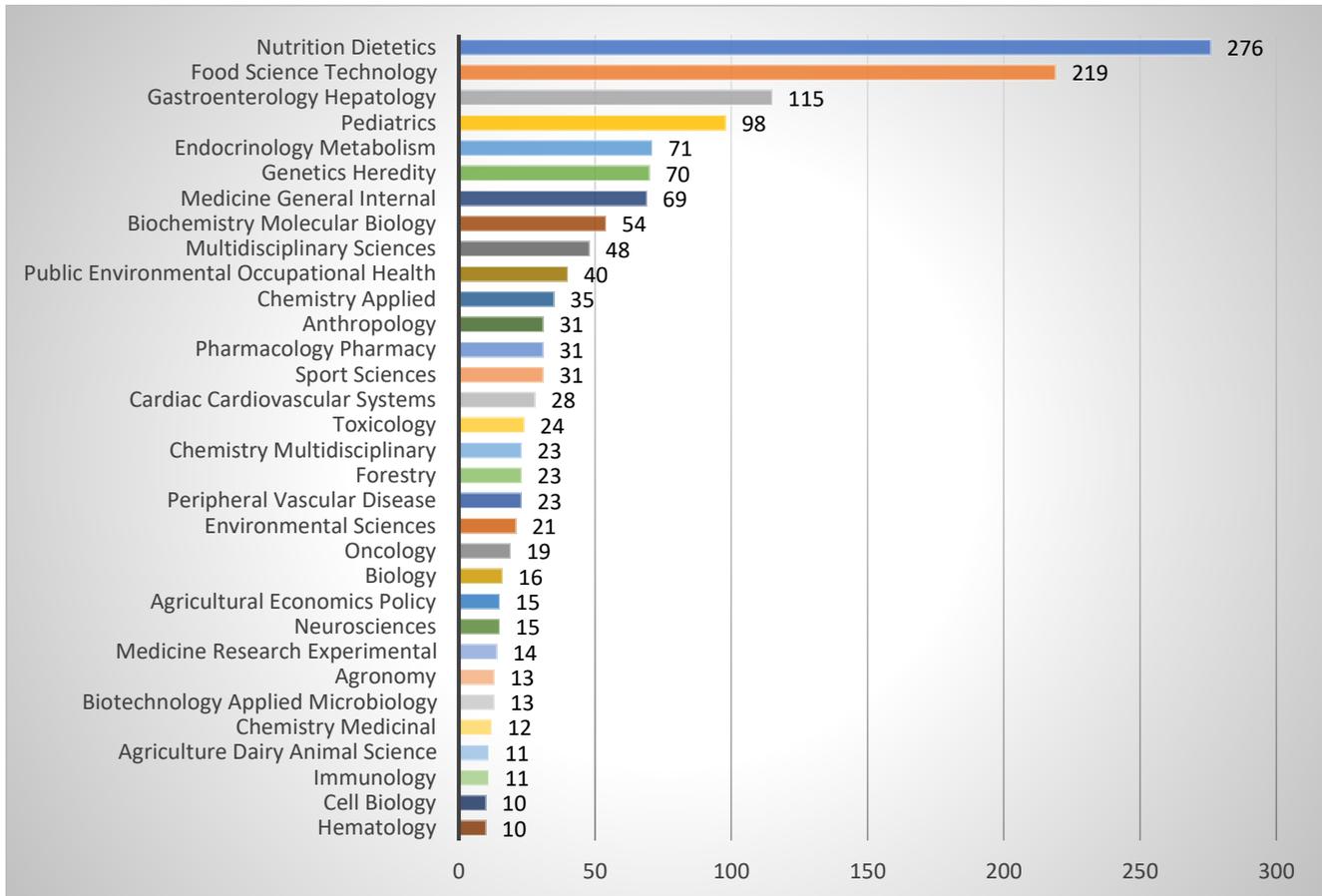

Figure 7. WoS subject categories with more than 10 nutrion-related articles published by Croatian authors between 2010 and 2020

Scientific collaboration

Researchers from the following institutions collaborated on the 316 papers published by the national cooperation (Figure 7): University of Zagreb, Josip Juraj Strossmayer University of Osijek, University of Rijeka, University of Split, Institute for Medical Research and Occupational Health, Croatian Veterinary Institute Zagreb, Institute Ruđer Bošković, University Hospital Dubrava, Croatian Forest Research Institute, Faculty of Kinesiology Zagreb, Institute of Agriculture and Tourism Poreč, Croatian Agency for Agriculture and Food, University Hospital Sestre milosrdnice, University Hospital Merkur, University Hospital Osijek, Croatian Institute for Transfusion Medicine, Croatian Institute of Public Health, General Hospital Dr. Josip Benčević Slavonski Brod, Institute for Adriatic Crops and Karst Reclamation, Children Hospital Srebrnjak, Children Hospital Zagreb, Agricultural Institute Osijek.
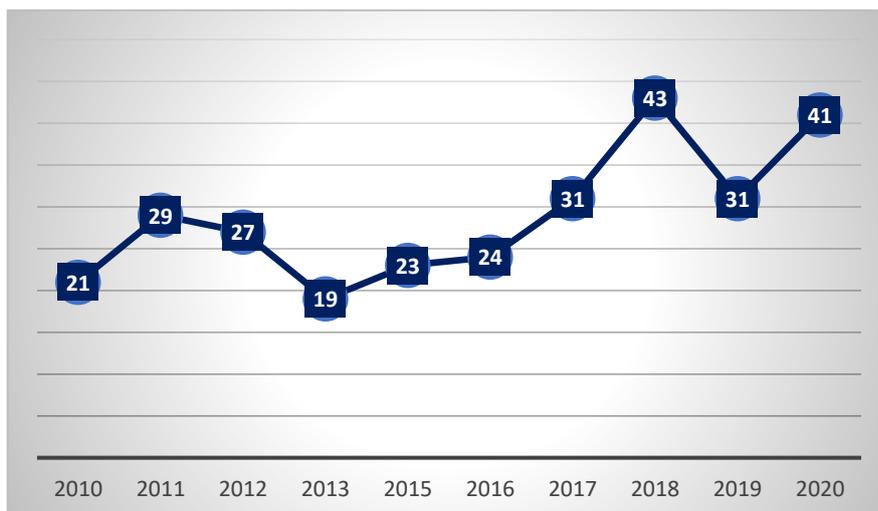
Figure 8. The number of articles published in the scientific field of nutrition by Croatian authors as part of the national collaboration between 2010 and 2020

University of Zagreb has the most intensive national collaboration (58%), followed by Josip Juraj Strossmayer University of Osijek (18%), University of Rijeka (13%), University of Split (5%) and Institute for Medical Research and Occupational Medicine and Croatian Veterinary Institute (each with 3%) (Figure 9). However, these numbers cannot be taken at face value; one must additionally consider the number of scientists per institution performing research on the topic of nutrition (which is not shown in this article).
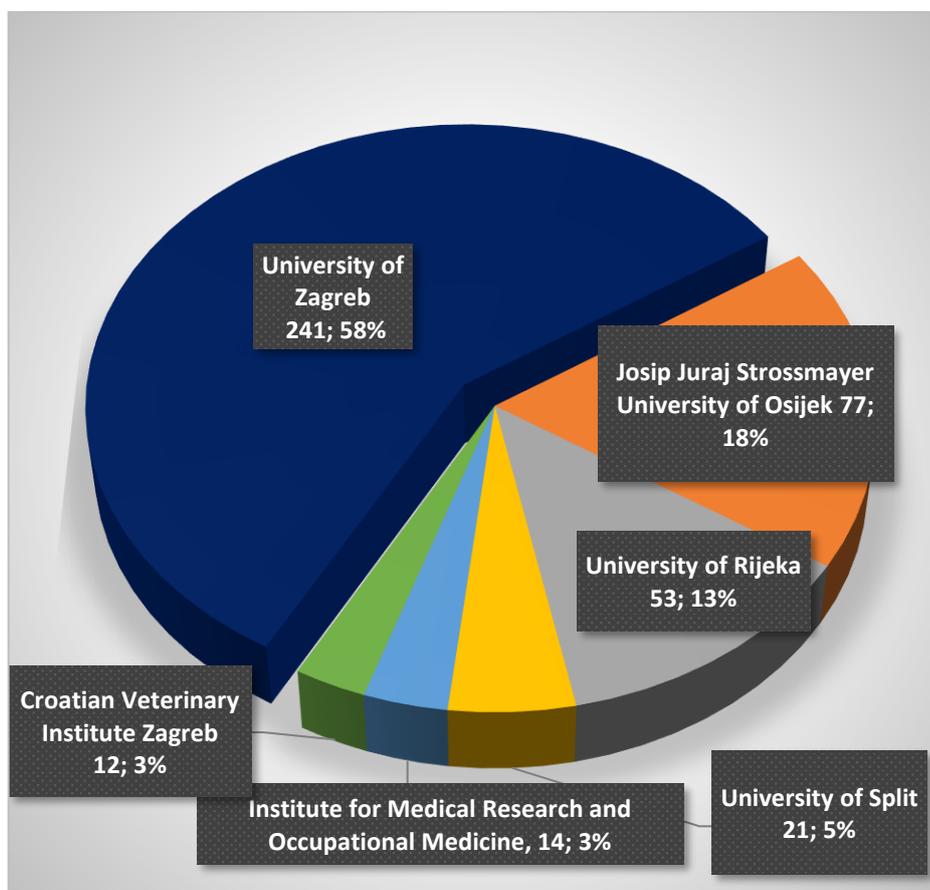

Figure 9. Dominant institutions in the articles published by Croatian authors in the scientific field nutrition in national collaboration in the period 2010 – 2020 (Institutions with more than 10 published articles were taken into metrics)

Croatian scientists have collaborated with scientists from 161 countries (Supplement Material 1). For visualization, only countries with 100 articles and more were considered (Figure 10). Cluster density denotes dependence of different collaborations on the themes, whereas circle size suggests scientists' and countries' centrality. A modularity value of 0.3898 indicates that network components are tightly coupled, while a mean silhouette value of 0.8073 suggests clustering configurations are of good quality. According to the frequency with which their names appear in the articles, the following countries are the most tightly coupled: Italy (367), Germany (334), Spain (329), England (329), USA (311), Netherlands (284), France (270), Poland (215), Sweden (211), Denmark (208), Switzerland (199), Canada (195), Scotland (190), Belgium (185), Australia (176), Norway (169), Finland (166), Israel (164), Greece (164), Czech Republic (145), Austria (144), Portugal (139), China (134), Slovenia (134), Hungary (127), Romania (116), Estonia (114), Brazil (108), Serbia (106), Iran (102).

Figure 10. Visualisation of international collaboration of Croatian authors in the scientific field nutrition between 2010 and 2020

Total of 14 clusters were formed in CiteSpace, however only 4 with tight inner connections are shown in Figure 11. Other countries have low connection (<10), which is indicator of a limited international collaboration. Different themes were covered by the most active collaboration, which is shown in Figure 11, through network of keyword clusters (Table 3).

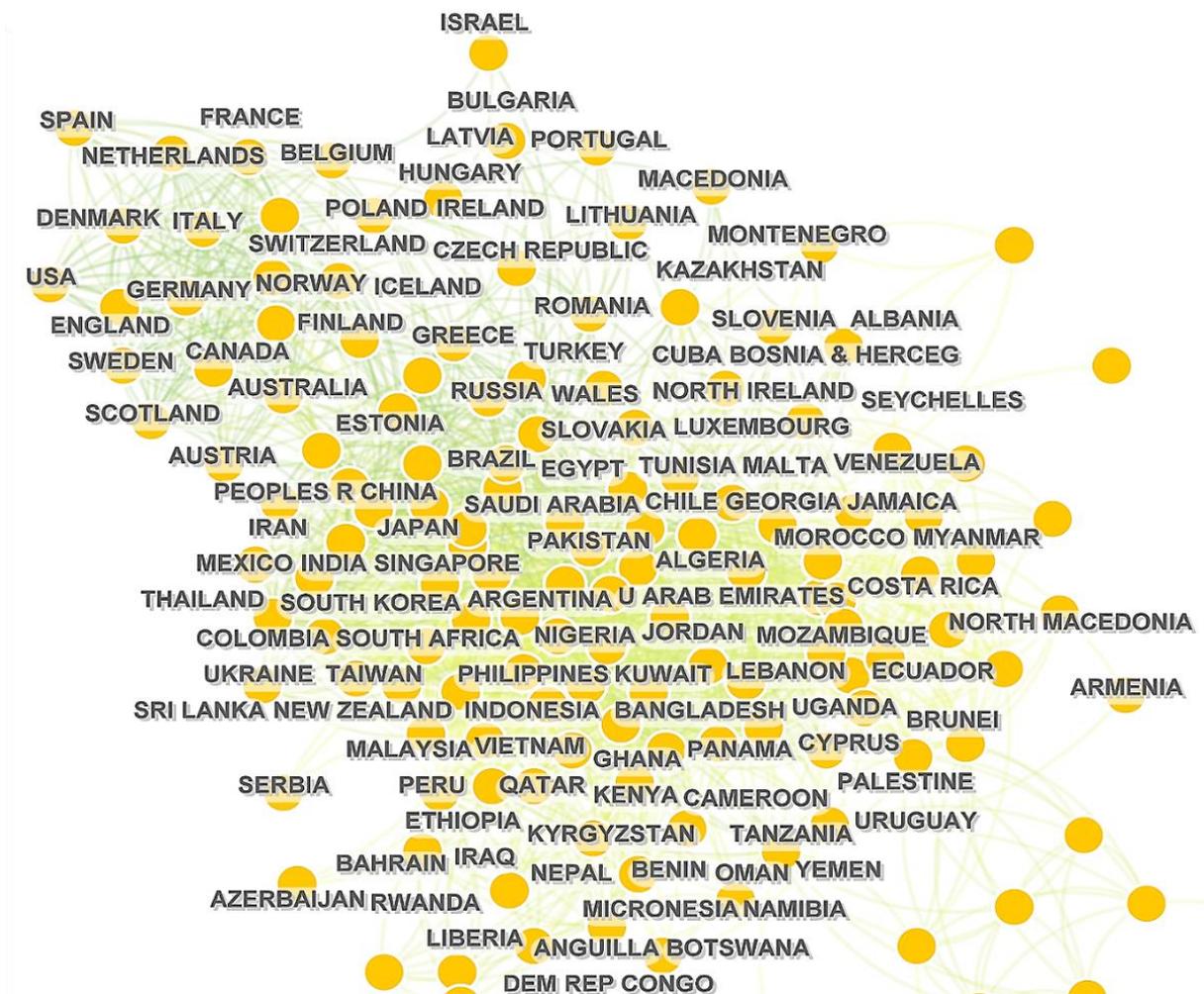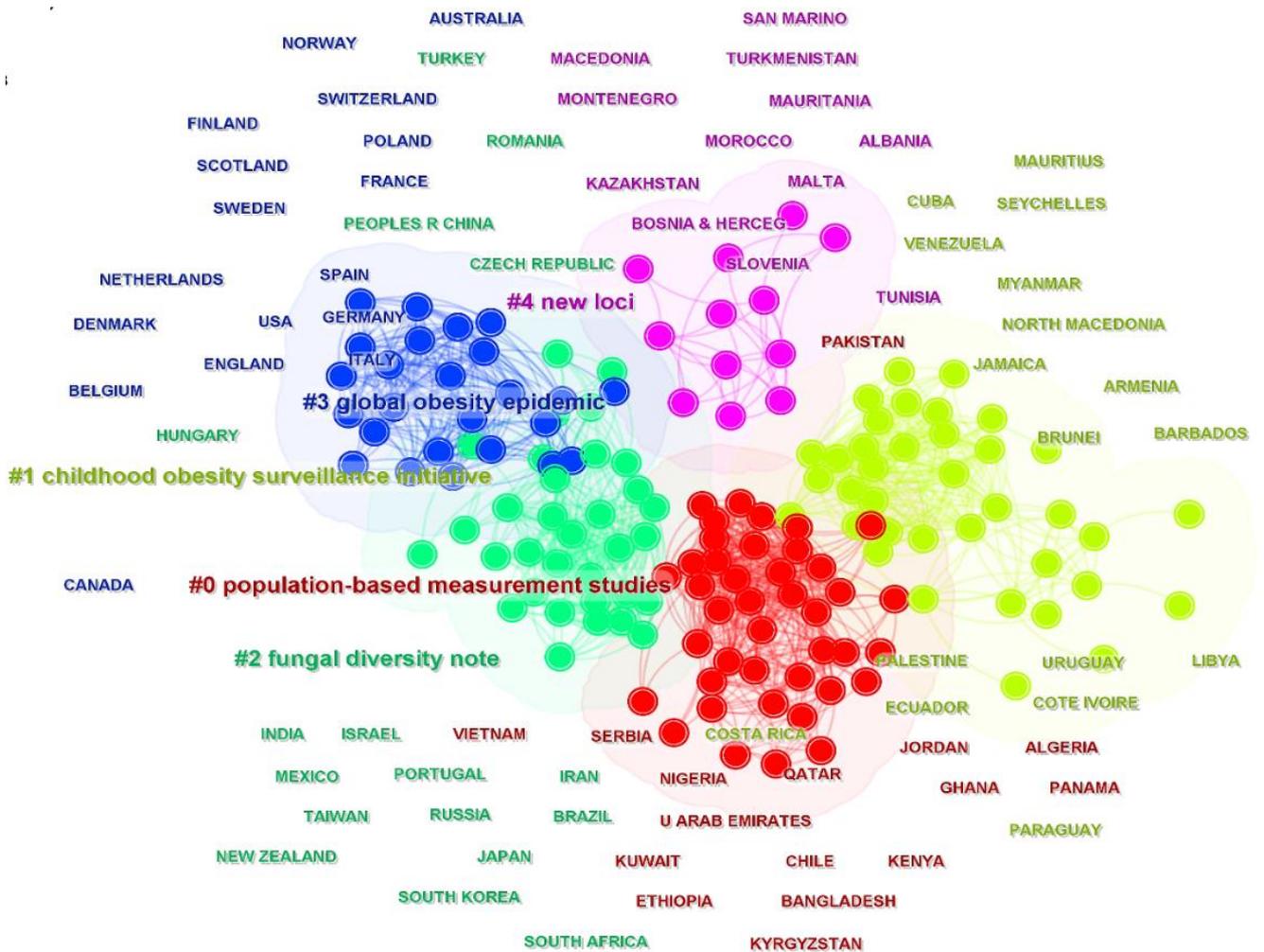**Figure 11.** Main clusters within international collaboration of Croatian authors
in the scientific field nutrition between 2010 and 2020

The largest cluster of (#0) population-based measurement studies began before 2010, peaked in 2015 and has been declining since 2019. These studies are the outcome of international scientific cooperation (Luxembourg, Qatar, Chile, Nigeria, Jordan, Pakistan, Tanzania, Cameroon, Serbia, …). Child obesity (#1) has been important subject since 2016 and is occupying scientists ever since. Nutraceuticals and their influence on health are clustered in group #2, with 2011 – 2015 being the peak of the research activity. The global obesity epidemic (#3) has been intensively studied until 2013 by Croatian scientists in collaboration of partners from England, Germany, Italy, and then Saudi Arabia. Food and loci interactions with various diseases (#4) have been widely researched up until 2019.

Table 3. Network of key words within international collaboration of Croatian authors in the scientific field nutrition between 2010 and 2020 in shown clusters (Source: CiteSpace II)

Cluster ID	Size	Silhouette	Mean (Year)	Label (LSI)	Label (LLR)	Label (MI)
0	41	0.757	2015	descriptive epidemiology; statistical issues; global health; blood pressure; cardiovascular disease | stress; vacuole; autolysosome; flux; lysosome	descriptive epidemiology (7.02, 0.01); burden of disease (4.64, 0.05); familial hypercholesterolaemia (3.49, 0.1); microsporidia (2.3, 0.5); neopereziida ord. nov. (2.3, 0.5)	arterial stiffness (0.15); outcomes research (0
1	37	0.79	2016	blood pressure; global health; population health; non-communicable disease; hospital malnutrition | hospital malnutrition; health insurance; nutritional management; global health; blood pressure	health insurance (4.84, 0.05); nutritional management (4.84, 0.05); subsidy (4.84, 0.05); hospital malnutrition (4.84, 0.05); child (3.83, 0.1)	arterial stiffness (0.05); outcomes research (0
2	33	0.794	2011	cardiovascular disease; familial hypercholesterolaemia; study design; arterial stiffness; health insurance | diabetes mellitus; heart failure; chronic kidney diseases; arterial stiffness; health insurance	recommendations (4.09, 0.05); pezizomycetes (4.09, 0.05); position paper (4.09, 0.05); lecanoromycetes (4.09, 0.05); nutraceuticals (4.09, 0.05)	arterial stiffness (1.78); outcomes research (1
3	25	0.904	2010	parenteral nutrition; fat emulsions; fatty acids; oropharynx cancer; tissue plasminogen activator | diabetes mellitus; temporal change; cyclical variation; oropharynx cancer; tissue plasminogen activator	body mass index (5.34, 0.05); parenteral nutrition (5.08, 0.05); nutrition (4.18, 0.05); infusions (3.56, 0.1); non-hdl cholesterol (3.56, 0.1)	nutrition assessment (2.1); parenteral (2.1); bath
4	12	0.868	2014	temporal change; diabetes mellitus; cyclical variation; familial hypercholesterolaemia; cardiovascular disease | autophagosome; flux; phagophore; stress; vacuole	temporal change (7.15, 0.01); incidence (4.04, 0.05); mortality (3.99, 0.05); bcaa (3.76, 0.1); world gastroenterology organization (3.76, 0.1)	bcaa (0.61); world gastroenterology organization (

Keyword analysis

Keywords in the articles were used to analyse research themes and focal points. Cite Space analysis revealed 1294 keywords based on the following criteria: g-index (k=25); LRF = 3.0, LBY = 5; e = 1.0. Size and connections between clusters distinguish topics that are more tightly coupled. Risk, prevalence, disease, children, health, cardiovascular diseases, meta-analysis, nutrition, risk factor are the most often used keywords in papers analysed. Figure 12 illustrates how visualisation of keywords corresponds to their frequency in articles, with colours representing the research subjects.
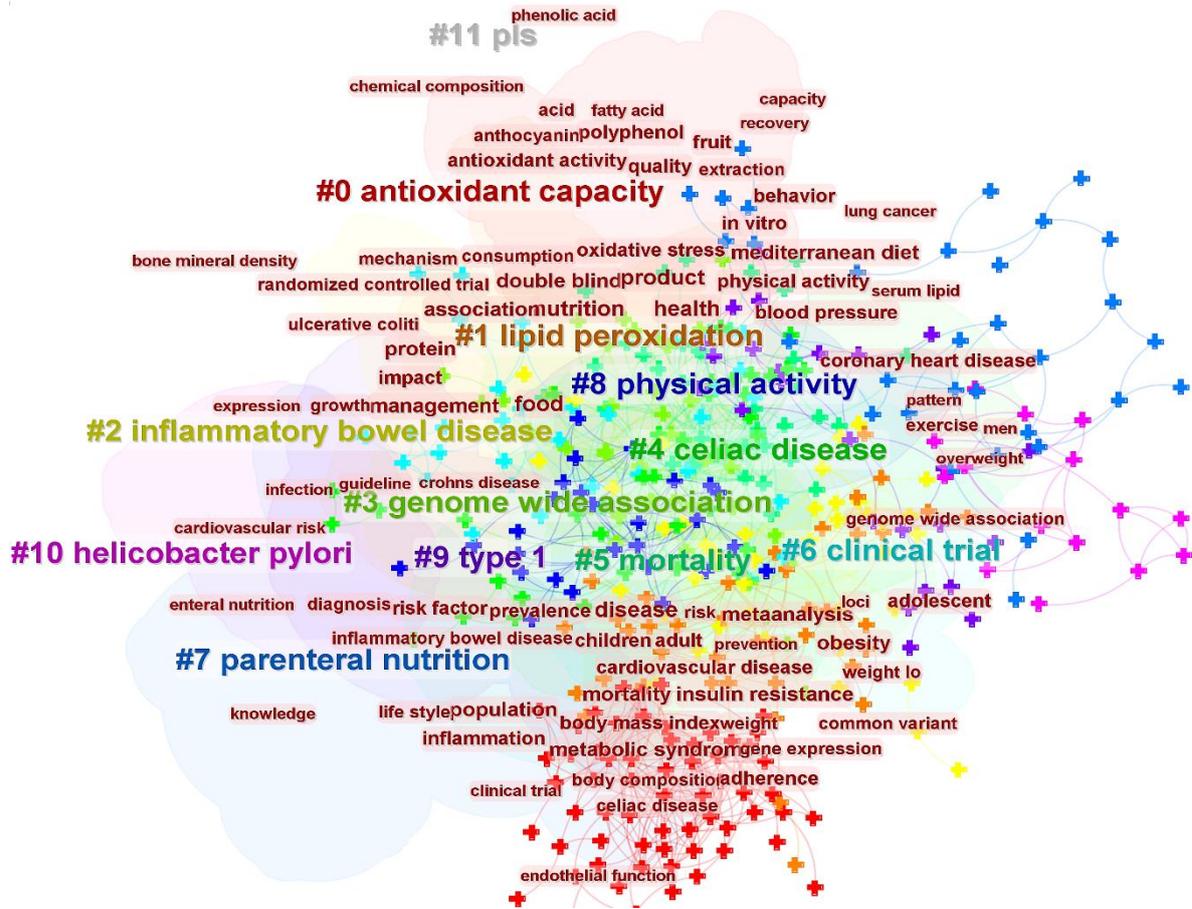
Figure 12. Bibliographic coupling of keywords in the articles published in the scientific field nutrition between 2010 and 2020 and their clusters

The bibliographic coupling of keywords resulted in 14 clusters, 11 of which had tough coupling of documents within clusters. These clusters are shown on a timeline (Figure 13). The cluster #0 has 92 documents with a silhouette of 0.778. Since 2014, the highest activity has been noticed in antioxidant capacity (25.99 1.0E-4); followed by antioxidant activity (29.72 1.0E-4), flavonoids (22.27 1.0E-4), polyphenols (18.54 1.0E-4) and children (15.14 1.0E-4).

Cluster #1 lipid peroxidation contains 68 documents with the lowest coupling between documents (S = 0.66). Documents are linked by keywords within research of diseases, pediatric patients and diet that continue to occupy the scientific community.

Cluster #2, inflammatory bowel diseases, is composed of 64 documents (S = 0.712) coupled through influence of diet on different bowel diseases.

Cluster #3 genome wide association has 52 tightly coupled documents (S = 0.741) regarding meta-anaylses of obesity and its link to genomic inheritance.

Cluster #4 peaked in 2016. Coeliac disease and influence of diet on its progress are theme in 47 documents coupled within the cluster (S = 0.695).

Cluster #5 morbidity is composed of 14 documents with tight coupling (S = 0.929), covering themes such as nursing, breast milk, physical properties, nutritive status, colorectal carcinoma, hygiene quality, therapeutical properties, chemical composition and nutritive status of breast milk.

Cluster #6 clinical trial covers 14 tightly coupled documents (S = 0.923) dealing with nutritive rehabilitation in parenteral diet at home, while cluster #7 (12 documents, S = 0.902) focuses on parenteral diet and lung diseases.

12 tightly coupled (S = 0.923) documents are clustered in #8, with systemic analyses of physical activity, hygiene, child growth, water quality and global load in Africa, and 8 documents regarding macro- and micronutrients in pregnant and breastfeeding women are coupled in cluster #9 (S = 0.963).

Cluster #10 is composed of only 5 documents (S = 0.982) regarding functional properties of different foods and their link to child obesity in children with *Helicobacter pylori.*
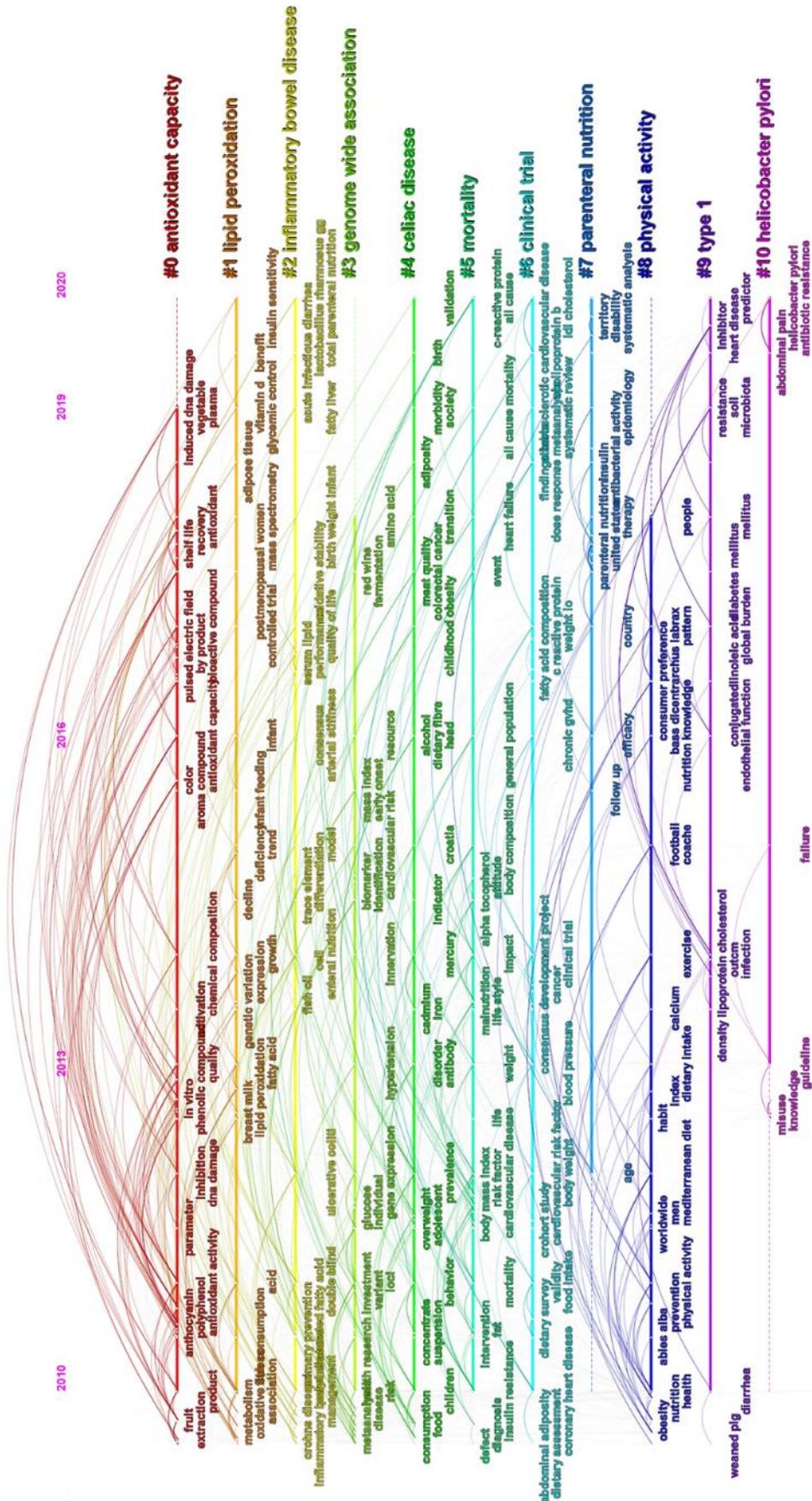
Figure 13. Timeline of bibliographic coupling of keywords in the articles published in the scientific field nutrition in the period 2010 – 2020 and their clusters

Cited reference analysis

Cluster analysis established focal points of research in the field of nutrition, with cited references as nodes. Criteria for selection were as follows: g-index = 25; LRF = 3.0, L/N = 10, LBY = 5; e = 1.0. Figure 15 represents results of visualisation of network of references, with N = 606, E = 2092, density = 0.0114, modularity Q = 0.8634 (>0.3), mean silhouette S = 0.6629 (>0.4) showing tight coupling of documents within each cluster.
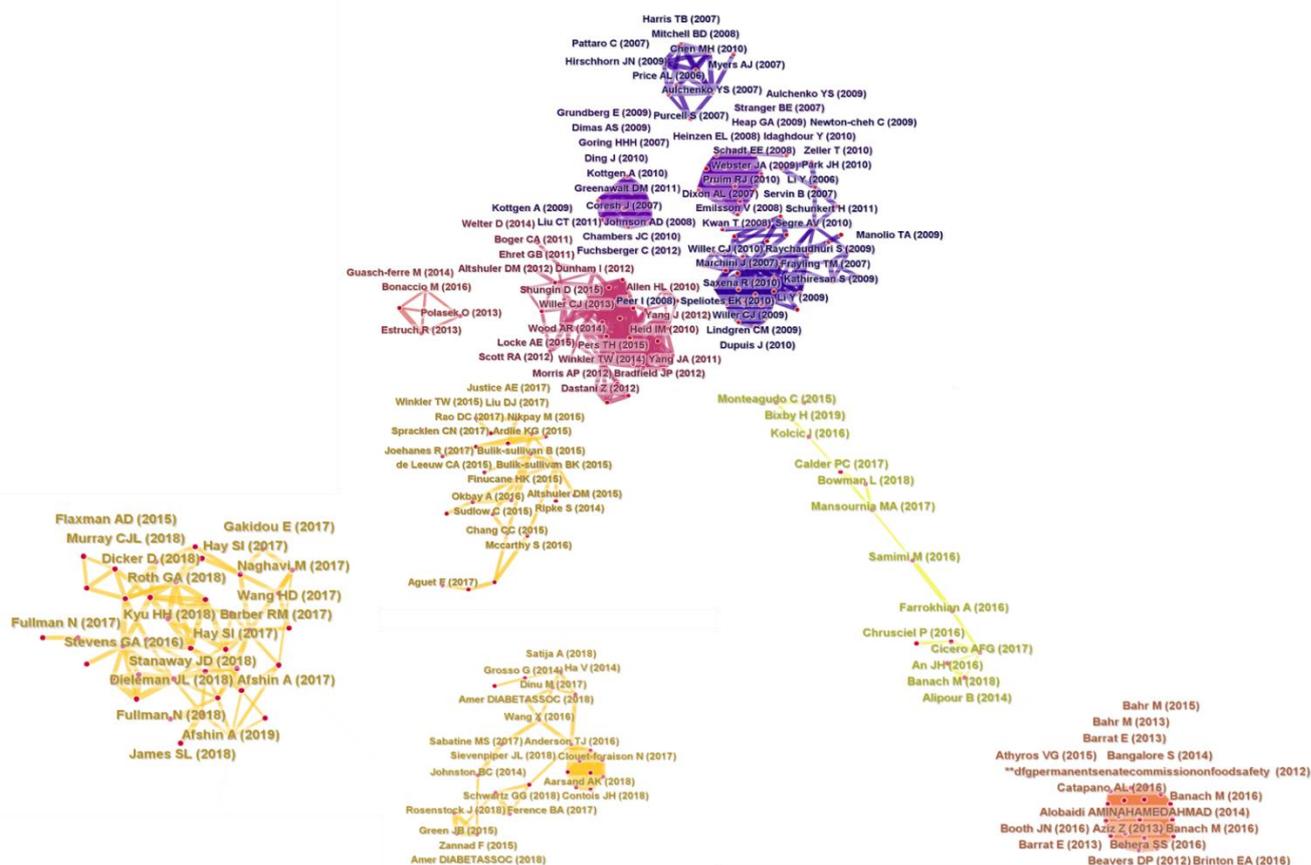

Figure 14. Visualisation of the network of cited references and their clusters in articles published between 2010 and 2020 in the scientific field nutrition

Analysis of co-citation references was used to determine focal points of research. Figure 15 displays the 25 top cited publications, as determined by their burst values. The red colour marks indicate periods when these publications were cited most frequently. Following articles written by Croatian authors are within top 25:

1. Danijela Bursać Kovačević, Jasenka Gajdoš Kljusurić, Predrag Putnik, Tomislava Vukušić, Zoran Herceg, Verica Dragović-Uzelac. (2016) Stability of polyphenols in chokeberry juice treated with gas phase plasma. Food Chemistry, 212, 323-331

2. Danijela Bursać Kovačević, Predrag Putnik, Verica Dragović-Uzelac, NadaVahčić, Martina Skendrović Babojelić, Branka Levaj. (2015.) Influences of Organically and Conventionally Grown Strawberry Cultivars on Anthocyanins Content and Color in Purees and Low-sugar Jams. Food Chemistry, 181, 94-100

3. Predrag Putnik, Danijela Bursać Kovačević, Marija Penić, Maja Fegeš, Verica Dragović-Uzelac. (2016) Microwave-Assisted Extraction (MAE) of Dalmatian Sage Leaves for the Optimal Yield of Polyphenols: HPLC-DAD Identification and Quantification. Food Analytical Methods, 9, 2385-2394

4. Predrag Putnik, Francisco J. Barba, Ivana Španić, Zoran Zorić, Verica Dragović-Uzelac, Danijela Bursać Kovačević. (2017) Green extraction approach for the recovery of polyphenols from Croatian olive leaves (Olea europea). Food and Bioproducts Processing, 106, 19-28

Top 25 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End
Marchini J, 2007, NAT GENET, V39, P906, DOI 10.1038/ng2088, DOI	2007	5.64	2010	2012
Dixon AL, 2007, NAT GENET, V39, P1202, DOI 10.1038/ng2109, DOI	2007	4.22	2010	2012
Raychaudhuri S, 2009, PLOS GENET, V5, P0, DOI 10.1371/journal.pgen.1000534, DOI	2009	3.81	2010	2013
Emilsson V, 2008, NATURE, V452, P423, DOI 10.1038/nature06758, DOI	2008	3.81	2010	2013
Segre AV, 2010, PLOS GENET, V6, P0, DOI 10.1371/journal.pgen.1001058, DOI	2010	3.8	2010	2015
Purcell S, 2007, AM J HUM GENET, V81, P559, DOI 10.1086/519795, DOI	2007	3.75	2010	2012
Schadt EE, 2008, PLOS BIOL, V6, P1020, DOI 10.1371/journal.pbio.0060107, DOI	2008	3.28	2010	2012
Speliotes EK, 2010, NAT GENET, V42, P937, DOI 10.1038/ng.686, DOI	2010	3.67	2011	2015
Willer CJ, 2010, BIOINFORMATICS, V26, P2190, DOI 10.1093/bioinformatics/btq340, DOI	2010	7.58	2012	2015
Allen HL, 2010, NATURE, V467, P832, DOI 10.1038/nature09410, DOI	2010	4.89	2012	2015
Yang J, 2012, NAT GENET, V44, P369, DOI 10.1038/ng.2213, DOI	2012	3.51	2013	2017
Yang JA, 2011, AM J HUM GENET, V88, P76, DOI 10.1016/j.ajhg.2010.11.011, DOI	2011	3.38	2014	2015
Wood AR, 2014, NAT GENET, V46, P1173, DOI 10.1038/ng.3097, DOI	2014	6.17	2015	2017
Willer CJ, 2013, NAT GENET, V45, P1274, DOI 10.1038/ng.2797, DOI	2013	3.77	2015	2016
Locke AE, 2015, NATURE, V518, P197, DOI 10.1038/nature14177, DOI	2015	4.89	2016	2018
Shungin D, 2015, NATURE, V518, P187, DOI 10.1038/nature14132, DOI	2015	3.69	2016	2017
Koubaa M, 2015, J AGR FOOD CHEM, V63, P6835, DOI 10.1021/acs.jafc.5b01994, DOI	2015	4.18	2017	2018
Kovacevic DB, 2016, FOOD CHEM, V212, P323, DOI 10.1016/j.foodchem.2016.05.192, DOI	2016	3.76	2017	2018
Kovacevic DB, 2015, FOOD CHEM, V181, P94, DOI 10.1016/j.foodchem.2015.02.063, DOI	2015	3.76	2017	2018
Rosello-soto E, 2015, TRENDS FOOD SCI TECH, V42, P134, DOI 10.1016/j.tifs.2015.01.002, DOI	2015	3.59	2017	2020
Putnik P, 2016, FOOD ANAL METHOD, V9, P2385, DOI 10.1007/s12161-016-0428-3, DOI	2016	3.34	2017	2018

Figure 15. The top 25 cited references, and their clusters with the strongest citation bursts within the articles published in the scientific field nutrition from 2010 to 2020. Red colour indicates the periods with highest number of citations.

Conclusion

This study examined articles in the field of nutrition authored by at least one Croatian author and indexed WoS CC database. The results show that publication trend is continually increasing, with the highest growth since 2016. Croatian scientists have good collaboration both nationally and internationally, with the most intensive collaboration with EU countries. The research in the field of nutrition is interdisciplinary, covering nutrition, food technology, medical sciences, molecular biology, chemistry, and other sciences, which is proved through journals in which results have been published. During the analysed period (2010 – 2020), the research focused on diet and its interaction with adult and child health, which is continuing trending.

However, this study does have a few limitations, the most notable of which are the following: the keywords that were chosen do not necessarily contain all of the articles that are connected to nutrition, and the data that is presented here only includes articles that are indexed in WoS CC.

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Supplement Material 1. Number of articles published in collaboration with scientists from abroad

Country	Nr of articles	Country	Nr of articles	Country	Nr of articles
Croatia	1173	Ukraine	50	Albania	11
Italy	375	Vietnam	48	Armenia	11
Germany	340	Lithuania	47	Azerbaijan	11
England	336	Qatar	47	Cuba	11
Spain	336	Sri Lanka	45	Liberia	11
Usa	318	U Arab Emirates	45	Myanmar	11
Netherlands	290	Kuwait	44	Zambia	11
France	273	Jordan	43	Namibia	10
Poland	221	Bulgaria	42	Paraguay	10
Sweden	215	Ethiopia	42	Seychelles	10
Denmark	211	Bangladesh	41	Uruguay	10
Canada	201	Chile	41	Cote Ivoire	9
Switzerland	201	Wales	41	Mauritius	8
Scotland	194	Ghana	39	Barbados	6
Belgium	188	Kenya	39	Libya	6
Australia	179	Thailand	39	Belarus	5
Norway	174	Kyrgyzstan	38	Bhutan	5
Greece	169	Algeria	37	Kosovo	5
Finland	168	Bosnia Herceg	35	Trinidad Tobago	5
Israel	165	Iraq	35	Fiji	4
Czech Republic	147	Latvia	35	Greenland	4
Austria	145	Panama	35	Malawi	4
Portugal	145	Nepal	34	Moldova	4
Peoples R China	137	Cyprus	33	Solomon Islands	4
Slovenia	137	North Ireland	33	Sudan	4
Hungary	129	Tunisia	31	Tajikistan	4
Romania	121	Lebanon	30	Tonga	4
Estonia	116	Luxembourg	29	Turkmenistan	4
Brazil	112	Cameroon	27	Uzbekistan	4
Serbia	111	Benin	26	Burundi	3
Iran	109	Bahrain	25	Dominican Rep	3
Russia	102	Kazakhstan	25	Gambia	3
Japan	101	Georgia	23	Mauritania	3
Iceland	100	Malta	23	New Caledonia	3
India	99	Morocco	23	San Marino	3
Ireland	96	Tanzania	23	Togo	3
Singapore	90	Mozambique	22	Burkina Faso	2
Turkey	87	Palestine	20	Cape Verde	2
Saudi Arabia	85	Uganda	20	Chad	2
Mexico	81	Yemen	20	El Salvador	2
South Africa	81	Costa Rica	19	Faroe Islands	2
South Korea	81	Ecuador	19	Guyana	2
Taiwan	74	Jamaica	19	Liechtenstein	2
Argentina	69	Oman	19	Mongolia	2
New Zealand	69	Micronesia	18	Papua N Guinea	2
Malaysia	66	Rwanda	17	Senegal	2
Pakistan	65	Anguilla	15	Suriname	2
Philippines	64	Montenegro	15	Bolivia	1
Colombia	61	North Macedonia	15	Cambodia	1
Slovakia	60	Brunei	14	Madagascar	1
Egypt	59	Venezuela	14	Nicaragua	1
Nigeria	58	Dem Rep Congo	13	Serbia Monteneg	1
Indonesia	51	Botswana	12	Sierra Leone	1
Peru	50	Macedonia	12	Zimbabwe	1