Abstract — Nutrition informatics is a rapidly growing interdisciplinary field of nutrition and dietetics sciences. As seen from large databases (as Pubmed, Weeb of Science etc.) in the field of informatics various applications have been developed that use nutritional data to provide tools that will help nutrition scientists, professionals and practitioners export useful conclusions and produce accurate and personalized guidelines concerning nutrition and diet. On the other hand, bibliography uses quantitative methods for the analysis of written publications, such as books, papers in journals, conference proceedings, etc. In this paper we use bibliometric measurements and methods in order to examine the growing association and interconnection of informatics applications and nutrition.

Keywords — Bibliometry, Informatics, Nutrition.

I. INTRODUCTION

Nutritional informatics is a rapidly growing field of activity for scientists and researchers of all kinds. Nutritional informatics knowledge and skills permeate all areas of the nutrition profession. Additionally, dietitians and dietitians must continually learn and update their computer science knowledge and skills to stay at the forefront of nutritional practice. Nutritional informatics is the connection between information, nutrition, and technology.

Bibliometry is a scientific field whose main purpose is to analyze statistical data and classify the flow of information resulting from scientific experiments or laboratory work. Scientists can use a variety of methods to analyze scientific data and evaluate huge datasets. In the past few decades, these tasks have been very difficult. Over the past few years, a huge amount of data has started to accumulate. The main question is how to use this huge amount of data in the future. Therefore, new technologies must be found.

II. NUTRITIONAL INFORMATICS REVIEW

The impact of Information Technology and the Internet is being felt and is constantly expanding in a number of areas of human activity. Their various applications have brought about significant changes in the way data and information are processed and transferred. The applications and uses of Informatics and the Internet in the field of Nutrition Informatics have been used effectively both in the clinical field and in the field of Public Health, as recently pointed out by A Association of Dietitia [1]. In particular, the Internet is now the main tool for providing services in the context of nutritional care by health care providers and nutrition units, as well as a tool for intervention in research studies, aimed at achieving hygienic and dietary changes [2]. Utilizing part of the "sedentary life" time that modern man consumes when interacting with the computer, for his participation in nutrition support programs has proved to be very constructive, making the Internet a modern tool for promoting health and nutrition.

Today, several informatics applications are successfully used in the field of nutrition and dietetics. The most significant of these include terms like [2]–[4]:

- **Nutrition software applications** (nutrition software), to support dietary work in the clinical environment. Features of this type of software include: nutritional needs assessment, use of diagnostic algorithms to determine suggested dietary interventions (decision support systems), analysis of clinical diets and dietary supplements.
- **Food databases and Food composition databases** in electronic form, such as the USDA Food Search for Windows (© US Department of Agriculture Nutrient Data Laboratory), for recording patient nutrition data in the context of the Electronic Health File.
- **Applications that provide support services** (such as keeping a record of clients, scheduling appointments) and financial-accounting support of a dietetic office.
- **Food systems management support systems**: use software applications to manage supplies, maintain order and distribution status.
- **Food supply surveillance applications**: software applications that serve traceability in food and foodstuffs, in order to protect Public Health from food hazards, epidemic outbreaks and outbreaks.
- **Applications that serve the education in the Science of Nutrition – Dietetics**: use of computers in the production of printed and electronic educational material.
- **Ontologies** which are used in the science of nutrition and dietetics: collections of data and terms in order to have term compatibility and decision-making mechanisms.
- **Social Networks** and **Social Media** that have changed the way users generate and obtain information. Also is an essential way for dietitians to connect with information resources and various colleagues and clients to exchange information.
- **Nutrition and Dietetics Software Evaluation**, where there is an evaluation of the various functional specifications that the software fulfills and concerns its inputs and outputs.
• Nutrition and Dietary intake Assessment Software, where there are web-based applications that collect Participants’ energy and nutrient intake data in order to compare dietary intakes (for energy, water, dietary fibre, macronutrients and micronutrients) and to do statistical analysis.

In Bibliography we can find a lot of papers that refers to the previous terms or on combinations of them. Numerous study approaches are available, each with pros and cons that present resources for many nutrition informatics experts.

In [5] there is a quite wide list of ontologies called Common Data Elements (CDEs). To improve the quality of data so that it may be used across sites and throughout time, standardized key phrases or ideas have been developed and established (https://cde.nlm.nih.gov/). CDE is made to facilitate consistent data gathering and analysis for a range of data types, including surveys, clinical data, and lab findings.

In [6] authors evaluate two greek language Dietetics programs used by most of the relevant Academic departments, private and public hospitals and clinics, and professional dieticians (as the authors argue). The paper provides a full evaluation of the functional requirements or specifications or characteristics. The authors tested whether the software applications satisfy all of the functional specifications stated in their reference pages. In [7]–[11] we can find web-based applications, software and generally dietary assessment tools (and comparisons of them) for the evaluation of dietary intake records.

In [12] authors present popular Nutrition Mobile applications while in [13] there is nutrition analysis software whereas in the [3] there is free nutrition software.

“Food system management” and “food system management support” is a main keyword for Nutrition Informatics according to [2] and [4], even though in [14] after keyword research procedure we can observe that, the most of the results concern “Drug Delivery Systems”. In Error! Reference source not found. the authors involve Governance structures in the inability of food systems to meet our long-term and comprehensive demands. They also demand that governance institutions broaden their scope and focus, increase coordination across industries, stakeholder groups, and geographic scales, and possess the political will and public support necessary to bring about change. In [16] authors describe the need for supporting food system transformation, while in [17] there is a presentation of food service management software. Finally, in [6] authors deal with food supply chain problems taking into consideration computational intelligence perspective.

Food databases and composition databases are a very important tool of nutrition informatics. We come across databases related to countries, types of diets or diseases. It is very important for dietitians, practitioners and academics to consult and refer valid databases. The USDA databases [17] are an important reference point for dietitian professionals, practitioners and academics. In [18] WHO, authors have made a review about the use of nutrition data, and they refer other important databases, as National Health and Nutrition Examination Survey (NHANES), the African Network of Food Data System (AFROFOODS) and the International Network of Food Data Systems (INFOODS).

III. BIBLIOMETRY

Bibliometric indexes used to evaluate the research performance of individual researchers-scientists include production measures (number of published papers, possibly divided by the academic age) and impact measures (number of received citations, possibly divided by the academic age or by the number of publications). The most famous bibliometric index is the H-index (also called as Hirsch index or Hirsch number because of Jorge E. Hirsch inventor of this index). H-index is an author-level metric that measures both the productivity and citation impact of the publications.

Measuring the productivity, we can summarize the current status of the literature (quantifying the literature). The results are quantitative and not qualitative. By mapping the literature, we can not only identify what is known, but also, where there are scientific gaps: a critical issue in advancing research and designing PhD research programs and also it is a method to help new research students to find research areas in a discipline.

IV. METHODOLOGY

In order to determine the impact of a particular researcher or an institute on the scientific community, we use as a basis, productivity index, a very important index for Bibliometry. Index of Productivity is the essential index in order to calculate other very important indexes for relative analysis. It counts the number of articles published in scientific journals during a specific time frame.

Utilizing the productivity index entails conducting a thorough literature search using online databases and other sources to locate all pertinent papers that meet certain requirements (keywords and combinations of them systematically identifying the literature).

By mapping the literature, we may not only determine what is known but also where there are scientific gaps. This is important for furthering research, developing PhD research programs, and it is also a way to assist new research students identifying topics of study in a field.

Using a Python-based intelligent computing mechanism (programming code)[19], [19]–[28], we measured weekly productivity of scientific articles for the above keyword combinations related to nutrition and computer science. Our investigation focused on the central Pubmed database.

Additionally, we calculated the weekly and the monthly productivity variations and weekly and monthly productivity averages.

V. EXPERIMENTAL AND COMPUTATIONAL DETAILS

The duration of research was from January to June of 2022. An overall view of our investigation is the following: The weekly measurements of productivity, the weekly variations of productivity and the monthly variations of productivity. Furthermore, we calculated the weekly averages of productivity. In the followings we present a part of our results, especially the results that concern the most
and the less popular keywords combinations that concern total productivity. Furthermore, we present results of weekly variations productivity. We detect where we have increasing, decreasing or stable trends of productivity on a weekly base and finally we present weekly productivity on average.

The nutrition informatics terms that have been studied in this work in order to draw and possible correlation with informatics terms was food composition databases, food service systems management, food supply surveillance, nutrition databases, food databases, nutrition informatics, nutrition ontologies, nutrition ontology, food ontologies, food ontology, social networks and social media and finally nutrition application.

The basic goal of our ICT system was the ability to search for those nutrition informatics terms supplied by the user and identify any connections with terms such as food, nutrition, databases, and the other terms combinations we researched in this study. Our investigation based on how frequently they are met together in several papers stored in PubMed. Our research focuses on Central PubMed database (is a famous database of US Center for biotechnology information and is a part of US Library of Medicine where we can find biomedical literature) [14]. The difference between PubMed and Central PubMed is that PubMed contains the abstracts of publications in the database while Central PubMed is a full text repository, which contains the full text of publications in the database. There are much more results in Central Pubmed than the simple PubMed. The results from this database include results from many scientific journals (almost 3800 journals) [14].

From the previous reviewed terms, we investigated some of them and its combinations. More specifically we investigated: "food composition databases", "food supply surveillance", "Nutrition Databases", "Nutrition Informatics", "Nutrition Ontologies", "Nutrition software", "food databases", "Nutrition Ontology", "food service system management", "food system management", "nutrition application", "Food Ontologies", "Food Ontology".

In a high level of productivity (more popular) we meet the combinations "food system management" with almost 450,000 publications, "Nutrition software" with 300,000 publications and "nutrition application" with almost 250,000 publications (Fig. 1).

The lowest productivity appears in combinations with the terms "ontology/ies" and "Nutrition Informatics" with a total publications number of productivity between 2,000 and 35,000 publications (Fig. 2). In addition, the productivity of "food composition databases" is considered very low (almost 44,000 publications).

Fig. 1. Keywords combinations with biggest productivity.
In Fig. 3 we can see the articles total productivity for all investigated keywords combinations.

The weekly variation on research papers production is increasing (and so we can conclude that there is an increasing interest from scientific community) in combinations such as "Nutrition Databases", "Nutrition Ontologies", "Nutrition software", "food databases", "Nutrition Ontology", "nutrition application", "Food Ontologies", "Food Ontology", with a positive slope of trendline.

In Fig. 4 we present some characteristic graphs of the previous combinations. In these graphs we can find how many papers are produced every week on the specific keyword combinations.

For other combinations such as "food composition databases", "food supply surveillance", "Nutrition Informatics", "food service system management", "food supply surveillance", "food system management", "nutrition application" the weekly variation shows stability with the slope of trendline being almost 0 and the trendline almost horizontal.

In Fig. 5 we present some characteristic graphs of these combinations. In these graphs (as well as in the previous) we can do a remark. There is a very strange value in 19th week, where for various combinations there is a big we can ignore this special value, especially for weekly variations.

Especially for the combinations with the terms "ontology/ies", "food" and "nutrition", with the lowest productivity so far, we made a summation study. We added the results for every combination of the previous terms, and we present the results in Fig. 6 for productivity (first graph) and weekly variation (second graph).
Fig. 4. Increasing weekly productivity variation.

Fig. 5. Stable weekly variation productivity.
The results in Fig. 6 show us a particular interest of scientific community for "ontology/ies" in nutrition informatics field, last weeks.

Another very interesting result in our investigation is the weekly variation averages. In other words, how many papers are produced per week on average for every keyword combination.

In Table I we present the weekly average productivity for the amount of combinations we investigated.

Finally, we can present a small amount of results for keywords combinations that we have just begun to investigate (6 weeks ago). These keywords have great appeal both to scientific community and nutrition informatics applications users. These keywords combine terms such as "food", "nutrition", "social media" and "social networks". We present the results (Fig. 7 for total productivity and Fig. 8 for weekly average productivity). Despite the fact that it is only a short time that we have been researching them, they show a good increase in productivity every week with a quite well increased slope of trendline (Fig. 8).

<table>
<thead>
<tr>
<th>Keywords Combinations</th>
<th>Weekly Average Productivity</th>
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<tbody>
<tr>
<td>Food composition databases</td>
<td>210</td>
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<tr>
<td>Foodservice systems management</td>
<td>10</td>
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<tr>
<td>Nutrition Databases</td>
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<tr>
<td>Nutrition Informatics</td>
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<td>Nutrition Software</td>
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<td>Food Databases</td>
<td>491</td>
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<tr>
<td>Nutrition Ontology</td>
<td>85</td>
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<tr>
<td>Food Service system management</td>
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<tr>
<td>Food Ontology</td>
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</table>
VI. CONCLUSIONS AND FUTURE WORK

The work presented in this paper demonstrates the impact of nutritional informatics on research interest in the scientific community and shows which fields are developing faster.

After this quite wide review and the bibliometric analysis that we presented, the most important issues that concern (and will concern in the future) the interdisciplinary field of Nutrition Informatics are the followings:

- the interconnection of applications with valid data and databases,
- the evaluation of applications for nutrition and dietetics,
- the security of the personal data of users who use such applications mainly from mobile devices,
- the interconnection of applications with artificial intelligence mechanisms and ontologies, in order to produce accurate and personalized guidelines concerning nutrition and diet,
- the use of social media as means of promoting the business activity of professionals and practitioners and an essential way for dietitians to connect with information resources and various colleagues and clients to exchange information.

As future work, we hope to improve our method and expand the measurement in larger time frames and other scientific databases and expand the scope of our investigation. We are at beginning of investigation for terms such as software assessment, evaluation, social network, social media in combination with nutrition and food. Nutrition informatics is a rapidly growing researchers and developers’ area. Every day we discover a big amount of new applications that serve nutrition and dietetics professionals and practitioners. For example, we can refer to applications that can identify food ingredients and nutrients from a plate image using existing food databases and ontologies. A wide review in this area is in our future plans.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

REFERENCES


Dr. Stefanidis Vasilelos is a member of Laboratory Teaching Staff (L.TEA.S.) at the Department of Nutritional Sciences and Dietetics of the International Hellenic University. He has a Bachelor in Applied Informatics, PhD and MSc in Medical Informatics, PostDoc in Mechanical Learning and Bibliometry, MSc in Information Systems and MSc in Lifelong and Continuing Education. Finally, he is certified from Cisco as CCNA (Cisco Certified Network Associate Routing & Switching). His current academic research focuses on interdisciplinary fields of Medical Informatics, Nutrition Informatics, Health, Mechanical Learning and Bibliometry.

Dr. Poulos Marios is Professor of Information Science and Informatics department of Ionian University of Greece and Head of the Laboratory of Information Technologies. Since his PhD in the Theory of Pattern Recognition, Marios has acquired over 20 years of experience in the field of the Computational Intelligence. He was one of the founders of the biometric features of EEG since 1998. http://biometrics.mauergroup.org/types/eeeg.htm. He is also interested in Semantic Web-metadata, Biometrics System, Pattern Recognition, Computational Geometry, Neural Networks, Image Processing, Text Processing and Time series. He is a reviewer for numerous IEEE journals such as IEEE Transactions on Image Processing Journal, IEEE Transactions on Pattern Analysis and Machine Intelligence etc.

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