



Wikipedia, Google Trends and diet: assessment of temporal trends in the Internet users' searches in Italy

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Wikipedia, Google Trends and diet: assessment of temporal trends in the Internet users' searches in Italy

Abstract

We obtained data from Google Trends and Wikipedia in order to assess whether the analysis of the Internet search could provide information on the Internet users' behaviour/interest on diets. From Wikipedia, we extracted the number of times a page is viewed by users, aggregated on a monthly and seasonal basis. One-way ANOVA test was performed to evaluate the differences between the seasonal averages. We also used Google Trends to evaluate the frequency of the users' web searches. The Mediterranean diet was the most frequently consulted (33.9%), followed by the pescatarian (9.0%). Statistically, significant seasonal differences were found for Mediterranean diet, vegetarian, Atkins, Scarsdale, zone diets and pescatarism. The top 25 most commonly searched and consequent diet-related queries on Google resulted to be: Dukan diet, Dukan and weight loss. Our data could be useful to support information campaigns via the Internet, especially in the periods when the population is more receptive.

Keywords: big data, Wikipedia, diet, wiktrends, Google Trends

Introduction

Nowadays, an increasing number of people pays attention to their health (Gianfredi et al., 2020). Thanks to the impressive spread of the Internet and easy access to a large amount of information (not even correct), the web is becoming one of the most trusted sources of information even about health (Bragazzi et al., 2017). This is true also considering health aspects related to diet (Vincenza Gianfredi et al., 2019; Goodman et al., 2011; Wangberg et al., 2009). In the current digital era, an increasing number of original data sources and high amounts of data, called "Big Data", are even more available for several uses, including health-research activities (Gianfredi et al., 2021; Mahroum et al., 2018; Provenzano et al., 2021). According to De Mauro et al. "[Big Data] represent resources / assets of an informative nature characterised by such a high volume, speed and variety as to require technology and analytical methods specific for its transformation into value" (De Mauro et al., 2016). Big Data are characterised by the so-called 4Vs: Volume, Variety, Velocity, and Value (Hashem et al., 2015), which refer to the amount of generated data, the different types of data, the rapidity of data transfer, and the value that can be obtained by analysing these important amounts of data, respectively (Hashem et al., 2015). However, recently, two additional qualities have been ascribed to Big Data: Variability and Veracity. Variability represents

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3 the consistency of the data over time, whereas veracity refers to the accuracy, credibility,
4 truthfulness of the data. Big data include the novel data stream, which are defined by Althouse et al.
5 as “those data stream whose content is initiated directly by the users (patients)
6 themselves”(Althouse et al., 2015). Among them, Wikitrends is a promising new analytics
7 framework for Wikipedia, offering the number of visualizations of Wikipedia pages(Gerguis et al.,
8 2017). Wikipedia is a free, no-profit, online encyclopedia, created and edited by volunteers from
9 around the world. Wikipedia uses the power of the online community to create and edit
10 encyclopedia-like articles which are then available for free. Currently operating in 303 languages,
11 Wikipedia has around 1.5 million articles available in Italian. With a wealth of detailed information
12 on an almost unlimited range of topics, Wikipedia is a platform that could potentially be useful for
13 scientific research in many different areas(Wikipedia, 2021b).

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15 According to a previous publication, the Internet users frequently seek diet-related
16 information in order to find healthy recipes, search for healthy diet recommendations and
17 motivational information to change their diet, and lastly, lose weight most frequently in the
18 preparation of holidays(Pollard et al., 2015). Moreover, it should be considered that diet is one of
19 the health-related factors more influenced by trend. This is due to the progress of science, but also
20 to marketing. Indeed, the popularity of diet may be highly influenced not (only) because of
21 scientific soundness, but because of efficient marketing. In this respect, some examples are the
22 Atkins diet, intermittent fasting, weight watcher, the gluten free diet, detox diet, alkaline diet,
23 Palaeolithic, vegan, macrobiotic(Klein and Kiat, 2015; Kuchkuntla et al., 2018).

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25 Considering both the large use of the Internet for seeking diet information, and the large
26 attention based on diet, we assumed that assessing Wikipedia users, by analysing Wikitrends, can
27 give more insights on the Internet users' search behaviour on diet overtime, understand which diets
28 are more fashionable among the general population and whether there is a seasonality in the
29 searching activities.

30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 **Methods**

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50 The data for this study were collected from Wikipedia(Wikipedia, 2021a), the most
51 frequently used encyclopaedia portal. From Wikipedia, we extracted the number of times a specific
52 page is viewed by users; the data were extracted as daily data from July 2015 to January 2021.
53 Therefore, we aggregated data on a monthly, and then seasonal basis (Spring: March-April-May;
54 Summer: June- July-August; Autumn: September-October-November; Winter: December-January-
55 February). The one-way ANOVA test was carried out to evaluate the differences between the
56 seasonal averages. The searches for the pages in Italian were selected, the diets considered were:
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3 Mediterranean, Vegetarian (semi-vegetarian), Ketogenic, Atkins, FODMAP, Acid-base, Vegan,
4 Blood group, Paleolithic, Scarsdale, Kousmine method, Zone diet, Intermittent fasting,
5 Pescetarianism, Fruitarianism, Raw food, Macrobiotics; the name of the Italian pages of the diets were:
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8 Mediterranea, Vegetariana (semivegetarianismo), Chetogenica, Atkins, FODMAP, Acido-base,
9 Vegana (Vegetaliana), del gruppo sanguigno, Paleolita (Paleodieta), Scarsdale, Metodo Kousmine,
10 dieta a zona (metodo alimentare a zona), digiuno intermittente, Pescetarianismo, Fruttarismo,
11 Crudismo, Macrobiotica. Additionally, we used Google Trends, a big web-based open-source tool
12 that assesses the frequency of web searches of populations, offering a comparison in trends
13 stratified by location, time, category and search type. In the current investigation, we mined Google
14 Trends from inception (1st January 2004) up to 26th March 2021, searching for the word “diet” (in
15 Italian “dieta”).

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22 The statistical significance level for the analyses conducted was 0.05. The data were
23 analysed using the STATA statistical software, version 14.

24 25 26 27 **Results**

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29 As shown in Figure 1, the Mediterranean diet is the most frequently searched diet, with one
30 user out of three searching for it (33.9% of all the searches performed during the study period). The
31 second most frequently searched are the Pescetarianism and Macrobiotics diets, respectively with
32 9.0% and 9.1% of the total search, followed by the ketogenic diet with 8.4% of the searches. On the
33 contrary, Atkins, Intermittent fasting, Scarsdale diet, Vegan/Vegetalian and acid-base diets are the
34 less often searched with a frequency below 1.5%. Diets-related digital behaviour showed a
35 seasonality throughout the study period, with a peak during spring, considering the data obtained
36 both from Wikitrends (Figure 2) and Google Trends (Figure 3). Statistically significant seasonal
37 differences were found for the Mediterranean diet ($p < 0.001$), Vegetarian ($p = 0.020$), Atkins
38 ($p < 0.001$), Scarsdale ($p = 0.001$), Zone diet ($p = 0.03$) and Pescetarianism ($p = 0.04$), as reported in
39 Table 1.

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48 Table 2 reports the first 25 most commonly searched and consequent diet related queries.
49 Dukan dieta, Dukan (Dukan diet, Dukan) and Dimagrire (weight loss) were the first commonly
50 searched terms in Google (with 100%, 94% and 67%, respectively). On the contrary, Detox/Dieta
51 gravidanza/Dieta vegana (Detox/Diet in pregnancy/Vegan diet) and Dieta ipocolarica/ dieta detox
52 (low-calorie diet/ detox diet) were the least searched terms (with 14% and 13% respectively).
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Discussion

In this paper we investigated the Internet users' search behaviour on diet overtime, by analysing Wikitrends. This allowed us to identify which diets were more frequently searched and whether there is a seasonality in the searching activities. Based on our results, the Mediterranean diet, Pescetarianism, Macrobiotic and Ketogenic are the first four more fashionable diets. Interestingly, we noticed that the Mediterranean diet is characterised by the users' consistent and constant interest throughout the study period, similar to Pescetarianism, even if in a really lower scale. On the contrary, the Macrobiotic and Ketogenic diets have a completely different pattern. Indeed, Macrobiotic shows an important spike in March 2018, whereas Ketogenic shows an increasing interest starting from June 2019. Searching on the web, for potential reasons, we found that, in Italy, the Macrobiotic diet was mainly promoted by Mario Pianesi. He was an entrepreneur of the food sector, founder of the "Un Punto Macrobiotico", a macrobiotic association, with many locations in Italy. According to what reported by the media, it seems that the members of this association were required to follow a restrictive regimen, not only dietetic (usually the Macrobiotic diet is a mainly vegetarian dietary pattern with a preference for organic, local and whole foods), but it seems that they were also obliged to avoid official medicine to treat diseases. For these reasons, he underwent legal proceedings. Investigations were conducted in March 2018, when many tabloids (also on-line) relaunched the news about Mario Pianesi and the macrobiotic association. Considering all the above-mentioned aspects, we hypothesised that the peak in the Macrobiotic diet registered in March 2018 in the Wikipedia search volume could be related to this media event. For this reason, we assessed on Google trends the research trends of the word "Mario Pianesi" in Italy from 1 January 2004 to 26 March 2021. Even in this case a peak in the research activity was found in March 2018 (Supplementary Figure1a). Moreover, Google trends also offers the possibility to assess the geographical distribution of the search volume. We noticed that the highest research volume was recorded in the Marche Region, where the police investigation mainly took place (Supplementary Figure1b).

As aforementioned, the Mediterranean diet search volume is stably high overtime, despite the fact that it is the "oldest" diet among those assessed in this work. Indeed, the Mediterranean diet was first identified by Ancel Keys during the 1960s. Moreover, this is the diet with the highest number of high quality studies that have

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3 revealed the strong association between the Mediterranean diet and a lower risk of
4 several conditions such as, for instance, cardiovascular disease(Dinu et al., 2020),
5 several forms of cancer(Schwingshackl and Hoffmann, 2015), mental disorders and
6 overall mortality(Rosato et al., 2019). Although the Mediterranean diet continues to
7 remain the most frequently searched, emerging diets attract the interest of the general
8 population. Among them, the diet that has raised increasing attention is the Ketogenic
9 diet which, however, is not supported by the same amount/quality of evidence as the
10 Mediterranean diet (Supplementary Figure 2 reports the number of articles for
11 Ketogenic, Mediterranean and Macrobiotic diets in PubMed, by year). In fact, the
12 increasing success of the Ketogenic diet is mainly ascribable to the weight loss effect
13 observed; however, studies have failed to prove the beneficial effect of the Ketogenic
14 diet in treating obesity or diabetes(Joshi et al., 2019). Moreover, the Ketogenic diet is
15 the last issued low-carbohydrate diet, preceded by the Palaeolithic and Atkins diets.
16 This trend was also confirmed by our results, according to which the Palaeolithic and
17 Atkins diets research volume has decreased over time.

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19 Moreover, our results show statistically significant differences in the search
20 volume during seasons, showing a high number of research volume during the spring.
21 This is an interesting aspect that should be taken into account by experts in nutrition
22 because it highlights the public's need for information on diet particularly in spring.
23 This is indeed true considering that on the web a large amount of (dis)information is
24 available to the general public who may not always have the appropriate knowledge to
25 select good quality (preferable scientific) contents and interpret them appropriately
26 (Patel et al., 2020; Provenzano et al., 2020). Moreover, our results, considering both the
27 data obtained from Wikitrends and Google Trends, show which diets are more
28 fashionable among the general public and consequently to which diet researchers should
29 pay more attention in order to improve the scientific dissemination on the web. Indeed,
30 websites containing high quality information on the types of diets and their potential
31 health effects is fundamental in our society, where citizens (and even patients) like to be
32 informed or sometimes overinformed. In this context, the role of science communicators
33 (in this case mainly represented by dietitians and nutritionists) should adequately cover
34 and make the topic interesting for the Internet users(V. Gianfredi et al., 2019; Gianfredi
35 et al., 2018).

36 ***Strengths and limitations***

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3 Before generalising our results, some aspects should be taken into account. First
4 of all, several different aspects may influence the Internet search peaks, as for instance
5 news launched by mass-media, scientific researchers' results, or new rule introduction
6 (as for instance sugar taxation). It is important to consider that this type of data cannot
7 be analysed on an exclusive basis. On the contrary, such data have to be considered
8 complementary of traditional data collection systems. Moreover, even if the Internet has
9 expanded and speeded the connectivity among countries, providing access to a large
10 amount of data and information also to developing countries, not all people have the
11 same level of access. In this perspective, this analysis is limited to people who have full,
12 or at least partial access to the web. Lastly, these types of analyses can be potentially
13 affected by the so-called "filter bubble" effect, first introduced in 2011 and defined as
14 the tailored results that the Internet search engines offer to users based on their
15 preferences/previous searches(Curkovic and Kosec, 2018).

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17 On the contrary, these data contribute to the decrease of several biases, such as
18 social desirability and recall bias, and representativeness of the sample. Moreover, the
19 velocity of these data highly reduces the time lag between data collection and data
20 analysis (Althouse et al., 2015). Lastly, Big data and novel data stream improve data
21 dissemination(Althouse et al., 2015).

22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 **Conclusions**

37 The several data sources used in the current study confirm the high interest of
38 the general public towards diet. Although the Mediterranean diet continues to represent
39 the diet which raises the most interest, emerging diets (such as the Ketogenic and
40 Macrobiotic diets) have started to attract the interest of the general population, with a
41 seasonal cyclicality. These data could be useful to support information campaigns via the
42 Internet, especially during the period when the population is more receptive.

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55 **The authors' contributions:** DN conceptualized the study and wrote the manuscript.
56 OES and VG performed the analyses. SP and MN supported in literature review. VG
57 supervised the work. All Authors read and approved the last version of the manuscript.
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Table I. Seasonal distribution and differences in the number of times a specific page was viewed by users.

Diets	Spring (mean ± SD)	Summer (mean ± SD)	Autumn (mean ± SD)	Winter (mean ± SD)	p-value
Mediterranean	20950.3 ± 5229.7	9864.4 ± 4316.4	13976.5 ± 7152.8	16202.2 ± 4045.7	<0.001
Vegetarian diet (semi-vegetarian)	3413.5 ± 458.4	2733.8 ± 668.5	2852.4 ± 721.3	3351.5 ± 1007.5	0.020
Ketogenic diet	4304.2 ± 4121.8	3819.3 ± 3917.5	3295.7 ± 3135.2	3594.4 ± 3446.7	0.882
Atkins	839.5 ± 307.6	643.3 ± 249.9	527.4 ± 124.8	523.0 ± 237.6	<0.001
FODMAP	563.8 ± 777.5	605.4 ± 853.7	735.9 ± 877.3	666.6 ± 816.5	0.938
Acid-base diet	0.3 ± 0.6	1.0 ± 2.0	0.3 ± 0.6	0.4 ± 0.6	0.230
Vegan/Vegetarian	12.5 ± 6.8	9.2 ± 8.1	10.9 ± 10.5	9.5 ± 4.7	0.623
Blood groups diet	1150.6 ± 649.1	997.2 ± 606.5	1009.2 ± 714.3	1023.1 ± 585.7	0.901
Paleolithic/Paleo diet	2077.5 ± 985.0	2118.7 ± 890.7	2180.1 ± 1089.1	1932.7 ± 952.4	0.897
Scarsdale diet	664.5 ± 239.3	518.1 ± 128.9	424.1 ± 125.9	430.3 ± 209.6	0.001
Kousmine method	1357.6 ± 435.7	1235.3 ± 381.4	1240.5 ± 407.3	1209.0 ± 505.3	0.796
Zone Diet	2235.9 ± 621.5	1911 ± 744.8	1588.5 ± 497.2	1681.9 ± 735.6	0.033
Intermittent fasting	642.7 ± 1025.4	549.7 ± 798.9	386.3 ± 573.6	576.2 ± 980.4	0.842
Pescetarianism	4192.5 ± 1351.1	4048.9 ± 754.7	3413.3 ± 578.7	4650.8 ± 1991.7	0.048
Fruitarianism	3540.5 ± 1701.8	4092.1 ± 2379.5	3488.5 ± 1660.2	2987.7 ± 1418.9	0.381
Raw food	2900.3 ± 1252.3	2258.2 ± 713.6	2322.2 ± 832.2	2433.5 ± 902.4	0.220

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3	Macrobiotics	5502.3 ± 5925.8	3431.7 ±	3710.4 ± 1125.4	3502.7 ± 1141.4	0.174
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8	SD: standard deviation					
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10	Statistically significant (p<0.05) differences have been reported in bold.					
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60**Table II.** Diet-related queries in the study period (2004-2021) using Google Trends.

Commonly searched diet-related queries	
Term in Italian (English translation)	Search volume (%)
Dukan dieta* (Dukan diet)	100
Dukan* (Dukan)	94
Dimagrire^ (weight loss)	67
Dieta per dimagrire^ (weight loss diet)	45
Dieta dimagrante^ (slimming diet)	37
Dieta zona^ (Zone diet)	34
Dieta Mediterranea (Mediterranean diet)	32
Dieta chetogenica/Dieta del gruppo sanguigno (Ketogenic diet/ Blood group diet)	26
Dieta del riso*/Dieta colesterolo*/Dieta a zona^/Dieta settimanale (Rice diet)/Cholesterol diet/Zone diet^/Weekly diet	22
Colesterolo Cholesterol^	21

Dieta Mozzi ⁺ /Diet plank (Mozzi's diet/ Plank diet)	18
Dieta vegetariana/Dieta proteica (Vegetarian diet/Proteic diet)	16
Dieta Lemme [°] /Diete (Lemme's diet/Diets)	15
Detox/Dieta gravidanza/Dieta vegana (Detox/Diet in pregnancy/Vegan diet)	14
Dieta ipocolarica/ dieta detox (Low-calorie diet/ detox diet)	13

* for this type of diet there is no corresponding Wikipedia page

^ In Italian there are multiple ways to express the same concept

+ The name refers to the promoter of the blood group diet

°The name refers to the promoter of a high-protein diet

Figure I. Percentages of the number of times a specific page was viewed by users out of the total number of times all pages were consulted.

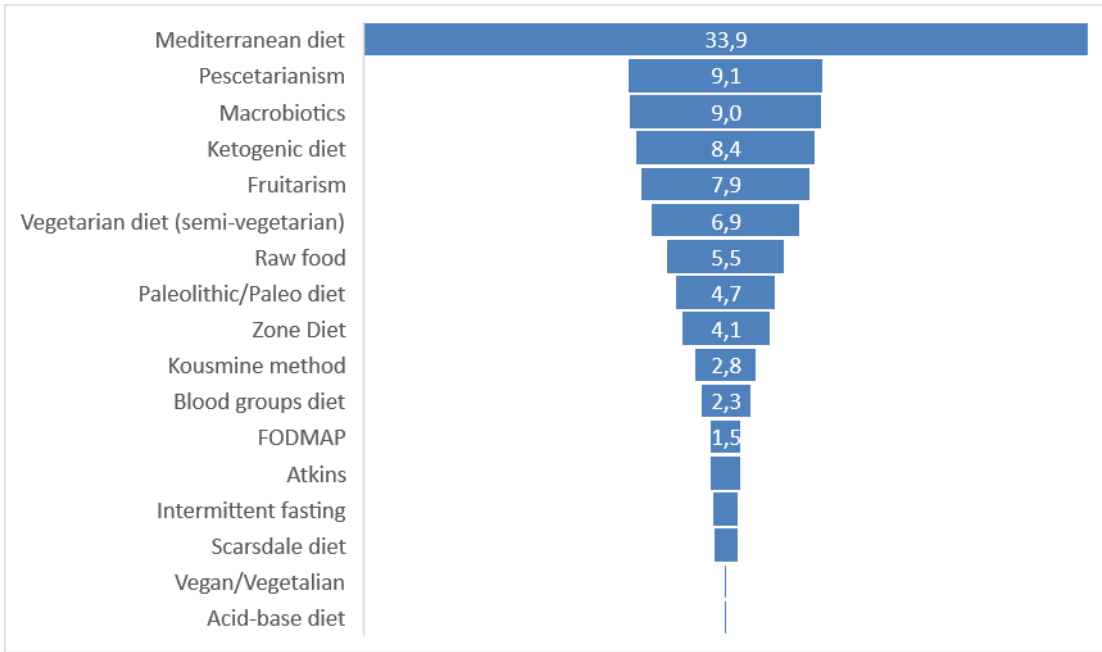


Figure II. Wikipedia curves with reference to the number of page views for Mediterranean, Vegetarian (semi-vegetarian), Ketogenic, Atkins, FODMAP, Acid-base, Vegan, Blood group, Paleolithic, Scarsdale, Kousmine method, Zone diet, Intermittent fasting, Pescetarianism, Fruitarianism, Raw food, Macrobiotics diets.

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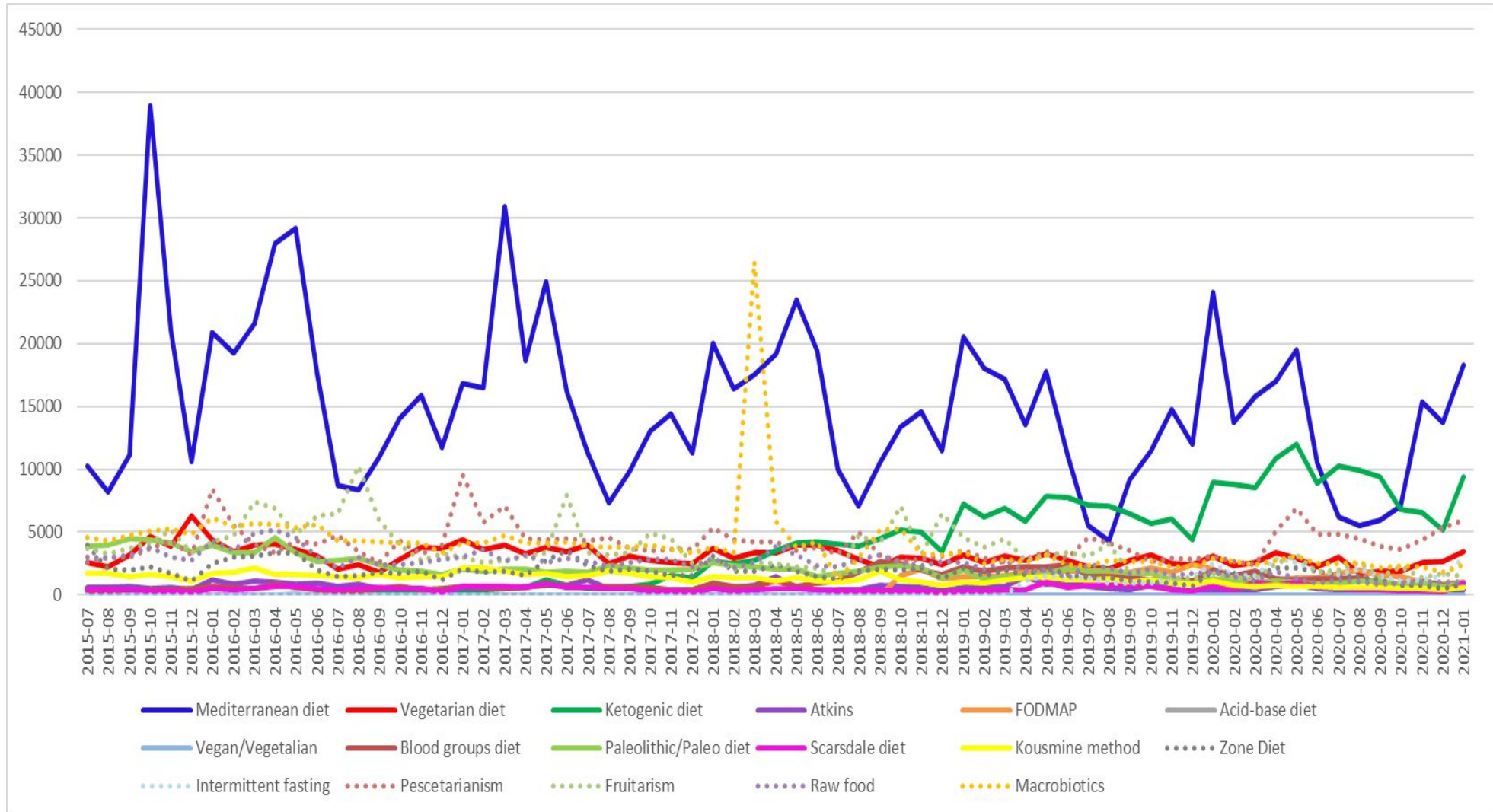
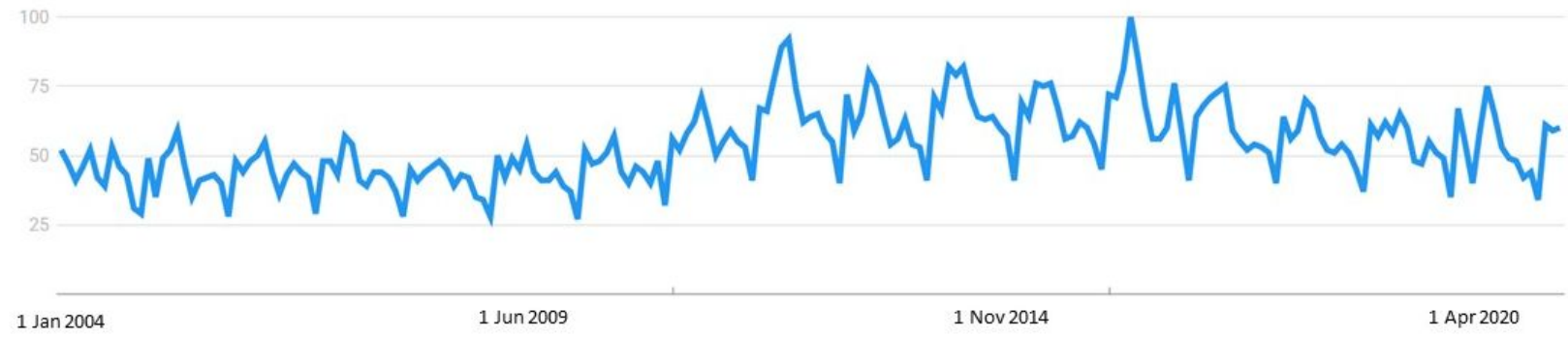


Figure III. Google Trends data from 1 January 2004 to 26 March 2021 for the research trends of the word “dieta” (diet in English) in Italy.

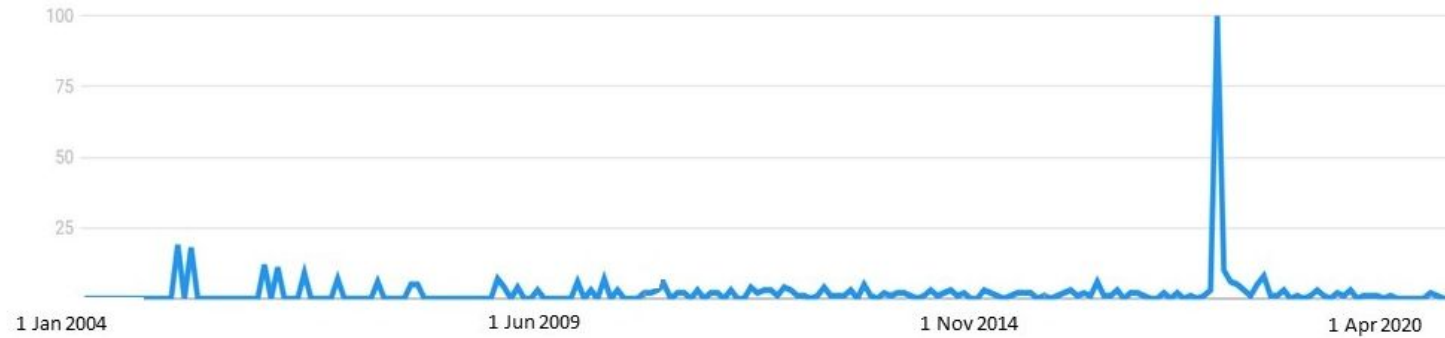


Food Science

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2 **Supplementary Figure I.** a) Google Trends data from 1 January 2004 to 26 March 2021 for the research trends of the word “Mario Pianesi” in
3 Italy; b) geographical distribution of the search volume.

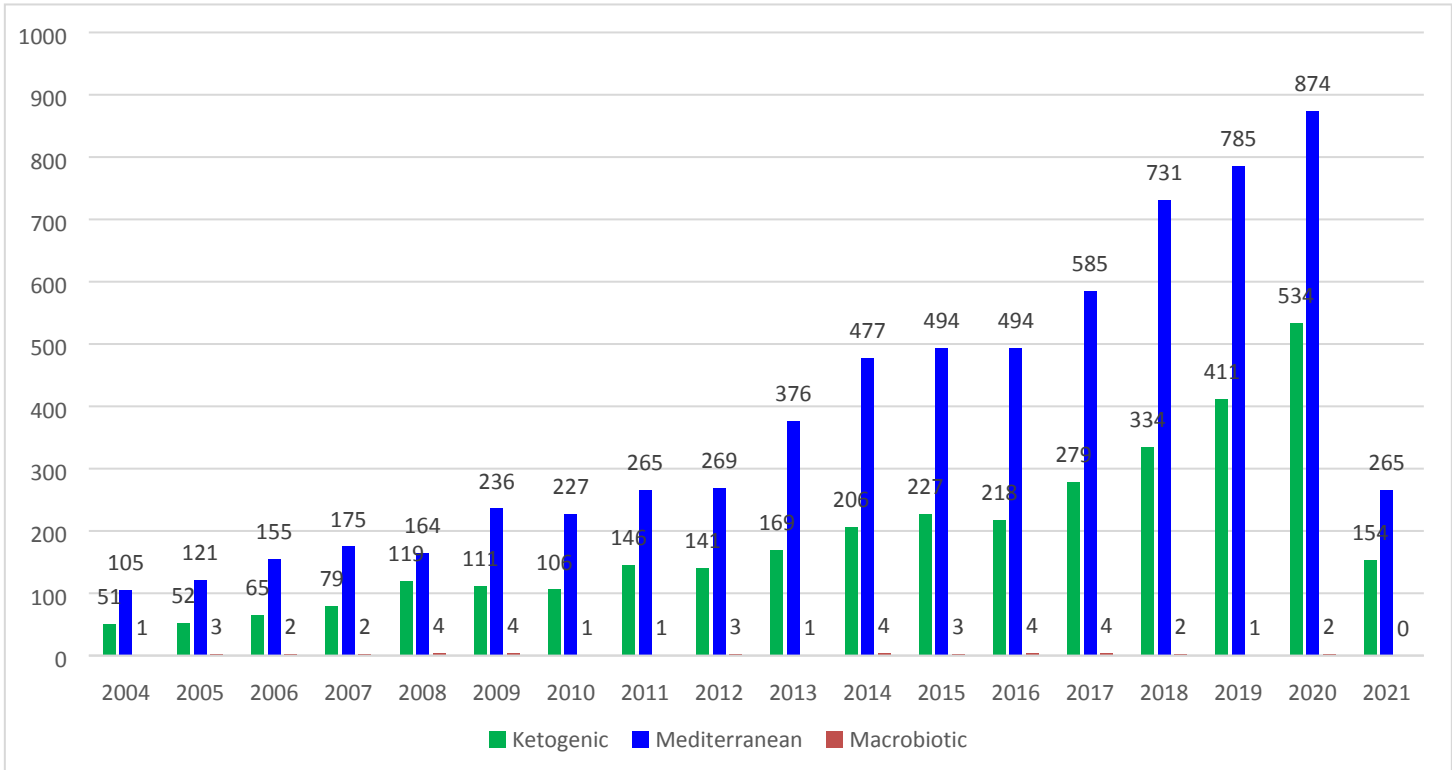
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Supplementary Figure II. Number of articles indexed in PubMed by year, for Ketogenic, Mediterranean and Macrobiotic diets.



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Nutrition and Food Science