

Semantic Analysis of Macedonian Medical Abstracts Indexed in the PubMed Database using GoPubMed

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Abstract

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Key words: medical science; PubMed database; GoPubMed; semantic analysis; Republic of Macedonia.

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Aim: The aim of this study was to analyze semantically medical abstracts from the Republic of Macedonia indexed in the PubMed database with GoPubMed.

Material and Methods: The analysis was performed with GoPubMed on March 18, 2013 in order to identify indexed papers affiliated with the country Macedonia in the PubMed database. A total number of 1469 abstracts were identified for analysis.

Results: Macedonian medical scientists published papers in a total of 400 different journals which have been indexed in PubMed database. The largest number of published papers was in the domestic journal Prilozi. Top twenty Macedonian authors published 72.4% of the total number of abstracts indexed in PubMed. A significant increase of abstracted papers during the period of 1989-2012 was recorded (from 50 abstracts to 180 abstracts, respectively) and a significant increase of relative research interest (from 0.00006 to 0.00018, respectively). Top author networks of the Macedonian scientists have shown that the largest group was composed of scientists working in the field of nephrology and related disciplines.

Conclusion: Requirements for at least one paper to be published and indexed in PubMed before a candidate approaches to the Philosophy Doctor Degree defence at the Faculty of Medicine, Ss Cyril and Methodius University of Skopje was a trigger for an increased number of publications indexed in PubMed in the last decade. A larger number of Macedonian medical journals should be indexed in PubMed in order to increase the impact of Macedonian medical scientists in the world.

Introduction

PubMed is a free database accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics. The United States National Library of Medicine (NLM) at the National Institutes of Health maintains the database as part of the Entrez system of information retrieval. PubMed was first released in January 1996 [1]. In addition to MEDLINE, PubMed provides access to: (a) older references from the print version of Index Medicus back to 1951 and earlier; (b) references to some journals before they were indexed in Index Medicus and MEDLINE, for instance Science, BMJ, and Annals of Surgery; (c) very recent entries to records for an article before it is indexed with Medical Subject Headings (MeSH) and added to MEDLINE; and (d) a collection of books available full-text and other subsets of NLM records [2].

Many PubMed records contain links to full text articles, some of which are freely available, often in PubMed Central [3] and local mirrors such as UK PubMed Central [4]. Information about the journals indexed in PubMed is found in the NLM Catalog [5]. As of 29 March 2013, PubMed has over 22,622,619 records going back to 1966 and about 500,000 new records are added each year [6].

Several databases, programs or WEB sites use PubMed as a source for further analysis of the abstracted papers (Fig. 1). BiomedExperts is a publication-based scientific social network that allows researchers to collaborate virtually in order to increase biomedical research. It involves more than 3,500 institutions from more than 190 countries. One of the most attractive features of BioMedExperts is that members receive automatic alerts - by e-mail and/or when signing in to the web interface of the service for publications authored by their contacts and by "bookmarked researchers", including authors that are not signed-up members of the service themselves [7]. Macedonian biomedical scientists are not adequately represented in BiomedExperts database and scientists are encouraged to register, log in, and correct personal profiles [8]. Pubget.com is a free service for non-profit institutions and their libraries and researchers. The site provides direct access to fulltext content from 450 libraries around the world. In January 2012 it was announced that Pubget was acquired by Copyright Clearance Center [9].



Figure 1: Central role of PubMed database with different databases, programs or WEB sites which use abstracts for analysis.

GO2PUB was developed to automatically enrich PubMed queries with gene names, symbols and synonyms annotated by a Gene Ontology (GO) term of interest or one of its descendants. It processes the result and displays the PMID, title, authors, abstract and bibliographic references of the articles. GO2PUB is based on a semantic expansion of PubMed queries using the semantic inheritance between terms through the GO graph [10]. Web server GoPubMed was introduced, which allows users to explore PubMed search results with the GO, a hierarchically structured vocabulary for molecular biology. GoPubMed has several advantages. First, it gives an overview of the literature abstracts by categorizing them according to the GO and thus allowing users to quickly navigate through the abstracts by category. Second, it automatically shows general ontology terms related to the original query, which often do not even appear in the abstract. Third, it enables users to verify its classification because GO terms are highlighted in the abstracts and each term is labelled with an accuracy percentage. Fourth, exploring PubMed abstracts with GoPubMed is useful as it shows definitions of GO terms without the need for further look up. GoPubMed is online at www.gopubmed.org [11, 12].

The aim of this study was to analyze semantically medical abstracts from the Republic of Macedonia indexed in the PubMed database with GoPubMed.

Material and Methods

A semantic analysis of PubMed database was performed with GoPubMed on March 8, 2013 in order to identify published papers from the field of medical sciences affiliated with the country Macedonia. The term was Macedonia[geo] with description "the country Macedonia" and with synonyms: Repubblica di Macedonia, Macedonia, Mazedonien, Repubblica de Macedonia, Repubblica, República de Macedonia, República da Macedónia, Macedônia, República da, Macédoine [12].

Relative research interest was calculated as: weighted publications per year (subject specific)/total weighted publications per year (in PubMed), where weighted publications per year = number of publications per year multiplied by relevance factors (as defined by PubMed) [13].

Results

Macedonian medical scientists published papers in a total of 400 different journals which have been indexed in PubMed database. The largest number of published papers was in the domestic journal Prilozi (272 abstracts or 18.5% of total number) followed by Med Arh (200 abstracts), Ugeskr Laeger (61 abstracts), Med Pregl (42 abstracts), Bratisl Lek Listy (37 abstracts), Int J Mol Sci (33 abstracts), Lijec Vjesn (23 abstracts), Acta Chir Iugosl (22 abstracts), and Croat Med J (21 abstracts). Less than 20 papers from the Republic of Macedonia have been published in each of the rest of the journals indexed in PubMed (Table 1).

The semantic analysis of terms in the abstracts from the Republic of Macedonia revealed that the majority of the terms were humans (1,005), followed by patient (748), adults (406), and middle aged (370). The rest of the publications with more than 100 terms belong to Evaluation Studies as Topic, Diagnosis, Aged, Child, Adolescent, Unknown term

Table 1: Number of papers from Republic of Macedonia published in different journals of PubMed database (1469 abstracts identified on March 18, 2013).

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Top Jo	urnals, Publications	99
1. 2	Prilozi, 272 Med Arb. 200	10
3.	Ugeskr Laeger, 61	10
4.	Med Pregl, 42	10
5.	Bratisl Lek Listy, 37	10
6. 7	Int J Mol Sci, 33	10
8.	Acta Chir lugosl, 22	10
9.	Croat Med J, 21	10
10.	Cmaj, 18	10
11.	Arn Hig Rada Toksikol, 15 Acta Pharm 14	11
13.	Spectrochim Acta A, 14	11
14.	Int J Artif Organs, 13	11
15.	Pediatr Nephrol, 13	11
10.	Nenhrol Dial Transpl 11	11
18.	Vojnosanit Pregl, 10	11
19.	Phys Rev E Stat Nonlin Soft Matter Phys, 10	11
20.	Renal Failure, 9 Transplant P 9	11
22.	Acta Med Croatica, 9	12
23.	Ann Urol, 9	12
24.	Bosn J Basic Med Sci, 8	12
25. 26	Int I Pharm 7	12
27.	Implement Sci, 6	12
28.	J Buon, 6	12
29.	Anal Bioanal Chem, 6	12
31.	J Pediatr Endocr Met, 6	13
32.	Plant Physiol, 6	13
33.	Radiol Med (torino), 6	13
34.	J Environ Sci Health A Tox Hazard Subst	13
35.	Iran J Allergy Asthma Immunol, 5	13
36.	Can Med Assoc J, 5	13
37.	Clin Nephrol, 5	13
39.	Clin Chem Lab Med. 5	13
40.	Allergol Immunopathol (madr), 4	14
41.	Akush Ginekol (sofiia), 4	14
42. 43	Num Immunol, 4 Skelet Muscle 4	14
44.	Interact Cardiovasc Thorac Surg, 4	14
45.	Radiat Prot Dosimetry, 4	14
46. 47	Med Lav, 4 Hippokratia	14
48.	Pediatr Int, 4	14
49.	Talanta, 4	14
50. 51	Adv Exp Med Biol, 4	15
52.	Epma J, 3	15
53.	J Forensic Leg Med, 3	15
54.	Cjem, 3 Soud Lok 2	15
55. 56.	Svst Rev. 3	15
57.	J Phys Chem A, 3	15
58.	World J Pediatr, 3	15
59. 60	Am I Med Genet A 3	15
61.	J Environ Sci Heal A, 3	16
62.	Clin Biochem, 3	16
63.	Turkish J Pediatr, 3	16
65	Tissue Antigens 3	16
66.	Acta Dermatovenerol Croat, 3	16
67.	Forensic Sci Int, 3	16
68. 69	Folia Med (plovdiv), 3 Can I Ophthalmol 3	16
70.	Fresen J Anal Chem, 3	17
71.	J Dairy Sci, 2	17
72.	Dermatol Ther, 2	17
74.	J Ovarian Res, 2	17
75.	Plos One, 2	17
76.	Clin Genet, 2	17
77. 78	Med Glas Liek Komore Zenicko-doboi	17
. 0.	Kantona, 2	17
79.	Acta Microbiol Immunol Hung, 2	18
80. 81.	J Aoac Int. 2	18
82.	Radiat Oncol, 2	18
83.	Angiol Sosud Khir, 2	18
04. 85.	Psychiatr Danub. 2	18
86.	Indian J Pediatr, 2	18
87.	J Neurosci Rural Pract, 2	18
88. 89	Angiology, 2 Trop Doct 2	18
90.	Toxins (basel), 2	19
91.	Nat Prod Commun, 2	19
92. 93	Stud Health Technol Inform, 2	19
94.	Microsc Res Tech, 2	19
95.	Nephron Clin Pract, 2	19
96. 97	J Genet, 2	19
98.	Nonlinear Dynamics Psychol Life Sci, 2	19
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Lasers Med Sci, 2 J Chem Phys, 2 Nucl Med Rev Cent East Eur, 2 Arch Gynecol Obstet, 2 Eur J Pediatr, 2 Arch Environ Contam Toxicol, 2 Clin Transplant, 2 Cases J, 2 Kardiol Pol. 2 6 Kardioi Pol, 2 Bioelectrochemistry, 2 J Sex Med, 2 Anal Chim Acta, 2 Eur J Cardiothorac Surg, 2 J Phys Chem B, 2 Genet Test, 2 J Mater Sci-mater M, 2 G Ital Med Lav Ergon, 2 Molecules, 2 Environ Monit Assess, 2 J Chromatorg B, 2 08 09 0 8. 9. J Chromatogr B, 2 Med Sci Monit, 2 Can J Surg, 2 Pharmazie, 2 Can Fam Physician, 2 20. 23. Clin Chim Acta, 2 Clin Chim Acta, 2 Boll Chim Farm, 2 Am J Kidney Dis, 2 Cardiologia, 2 Ann Cardiol Angeiol (paris), 2 Ann Dermatol Vener, 2 24. 6 Ann Dermatol Vener, 2 Hurn Mutat, 2 Ann Gastroenterol Hepatol (paris), 2 Plucne Bolesti, 2 Reumatizam, 2 Br J Health Psychol, 1 Thromb Res, 1 Pediati Infect Dis J, 1 Eur. J Parm Sci, 1 Evid a finited bis 5, 1 Eur J Pharm Sci, 1 Acta Crystallogr Sect E Struct Rep Online, 1 J Chromatogr A, 1 Noise Health, 1 Int J Psychophysiol, 1 Evid J J Grangel 1 6. Saudi J Kidney Dis Transpl, 1 Eur J Med Genet, 1 Acta Inform Med. 1 34 J Am Heart Assoc, 1 5. 6. Ann Epidemiol, 1 Neurology, 1 Eur J Public Health, 1 Eur J Públic Health, 1 Korean J Intern Med, 1 Food Chem, 1 J Clin Epidemiol, 1 J Cint Care, 1 Georgian Med News, 1 Environ Sci Pollut Res Int, 1 Clin Respir J, 1 J Neuroimaging, 1 J Mass Spectrom, 1 Korean J Urol, 1 Bmc Med Res Methodol, 1 Crit Care Res Pract, 1 Circulation, 1 8 3. 54. 55. 56. 57. 58. 59. 50. 51. Circulation, 1 Indian J Cancer, 1 Dent Mater, 1 South Med Rev, 1 Clin Ophthalmol, 1 Am J Physiol Lung Cell Mol Physiol, 1 Am J Physiol Lung Co..... Leg Med (tokyo), 1 Diabetes Metab Syndr, 1 6. Diabetes Metab Syndr, 1 J Addict Med, 1 Mol Reprod Dev, 1 Am J Infect Control, 1 Pharm Dev Technol, 1 J Appl Genet, 1 Minerva Urol Nefrol, 1 Pharmacoepidemiol Drug Saf, 1 J Cardiothorac Surg, 1 Mol Biol (mosk), 1 Resn Res 1 890 Resp Res, 1 Oncol Lett, 1 J Microencapsul, 1 Neuropsychiatr Dis Treat, 1 80. Indian Pediatr, 1 Cancer Genet, 1 N A J Med Sci (hamilt), 1 33. J Mater Sci Mater Med, 1 5. Can J Public Health, 1 6. Isrn Urol, 1 Ann Afr Med. 1 7. 8 Ann Afr Med, 1 Updates Surg, 1 Oral Health Dent Manag, 1 Nephrol Dial Transplant, 1 Anal Chem, 1 Vet Rec, 1 Ginekol Pol, 1 J Physiol Biochem, 1 Vasc Cell, 1 J Chromatogr Sci, 1 Andrologia, 1 89 90 6. 7. 8. 9. Andrologia, 1 Klin Onkol, 1 Global Health, 1

J Opt Soc Am A Opt Image Sci Vis, 1 Horm Res Paediatr, 1 Am J Phys Med Rehabil, 1 203. Int J Telemed Appl, 1 Transplant Proc. 1 Indian J Hum Genet, 1 Emerg Med J, 1 Rev Med Chil, 1 leee/acm Trans Comput Biol Bioinform, 1 Genet Test Mol Biomarkers, 1 Genet Test Mol Biomarker J Androl, 1 Int J Immunogenet, 1 Telemed J E Health, 1 Med Law, 1 Rev Med Brux, 1 Appl Radiat Isot, 1 J Rheumatol, 1 Clin Lab, 1 Diabetes Technol Ther, 1 J Allergy (caino), 1 216. 217. 218. 219. 220. J Allergy (cairo), 1 Cent Eur J Public Health, 1 Vis Exp, 1 Ophthalmic Genet, 1 Turk Kardiyol Dern Ars, 1 Acta Odontol Latinoam, 1 Acta Odonitol Latinoam, 1 Epileptic Disord, 1 Folia Morphol (warsz), 1 Aust Dent J, 1 J Pediatr Neurosci, 1 Forensic Sci Int Genet, 1 Proteomics Clin Appl, 1 Am J Drug Alcohol Abuse, 1 J Med Case Reports, 1 Biophys Chem, 1 Int J Environ Res Public Health, 1 Parasite, 1 225. 226. Parasite, 1 Toxicol Pathol, 1 237. 238. Medicina (kaunas), 1 J Mol Graph Model, 1 240. 241. Nonlinear Biomed Phys, 1 Environ Sci Health B, 1 Cancer Cell Int. 1 243. Health Serv Res, Water Sci Technol, 1 Hum Mov Sci. 1 246. Drug Chem Toxicol, 1 Euro Surveill, 1 Ling Surveill, 1 Appl Biochem Biotechnol, 1 Prikl Biokhim Mikrobiol, 1 Surv Ophthalmol, 1 Philos T Roy Soc A, 1 Bmc Res Notes, 1 Indian J Tuberc, 1 J Biomed Discov Collab, 1 Blood Cells Mol Dis, 1 Case Report Med, 1 Food Chem Toxicol, 1 Adv Med Sci, 1 J Hazard Mater, 1 J Drug Target, 1 Chirality, 1 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. Chirality, 1 Acta Ophthalmol, 1 263. Ren Fail, 1 Semin Dial, 1 265. Nefrologia, 1 Clin Rheumatol, 1 266. Ann Thorac Surg, 1 Comp Immunol Microbiol Infect Dis, 1 Foodborne Pathog Dis, 1 267. 268. 269. 270. 271. 272. 273. 274. 275. Skeletal Radiol Skeletal Radiol, 1 Semin Cell Dev Biol, 1 Tissue Cell, 1 J Urol, 1 J Appl Oral Sci, 1 J Clin Rheumatol, 1 J Basic Clin Physiol Pharmacol, 1 Recent Patents Cardiovasc Drug Discov, 1 J Opt Soc Am A, 1 Cogn Process, 1 Cardiol J, 1 Acta Biochim Pol, 1 276. 277. Cardiol J, 1 Acta Biochim Pol, 1 Graefes Arch Clin Exp Ophthalmol, 1 J Immune Based Ther Vaccines, 1 282. 283. 284. Cell Biochem Funct, 1 J Clin Neurosci, 1 286. Chemmedchem, 1 Iubmb Life, 1 Biom J, 1 Nucl Med Commun, 1 Clin Exp Dermatol, 1 J Toxicol Environ Health B Crit Rev, 1 J Biochem Bioph Meth, 1 Ann Ny Acad Sci, 1 Ann Chim-rome, 1 Eur J Pharm Biopharm, 1 Bone, 1 J Vasc Access, 1 Anadolu Kardiyol Derg, 1 Diab Vasc Dis Res, 1 Fish Shellfish Immun, 1 lubmb Life, 1 288. 293. 294. 295. 296. 297. 298. 299. 300.

Acta Paediatr, 1 301 J Ultras Med, 1 Int J Dermatol, 1 302 303. 304. Planta Med, 1 305. 306. Int J Infect Dis, 1 Gen Physiol Biophys, 1 Gen Physici Biophysici Ann Otolaryngol, 1 Chemosphere, 1 J Sep Sci, 1 J Matern Fetal Neonatal Med, 1 307 308 309 310 J Matern Fetal Neonatal Leukemia Res, 1 J Clin Microbiol, 1 Prog Urol, 1 J Biomat Sci-polym E, 1 Xenotransplantation, 1 Med Etika Bioet, 1 Clin Invest Med, 1 Bmc Public Health, 1 Minerya Gastroenterol C 311. 313. 314. 315. 316. 316. 317. 318. 319. 320. 321. Minerva Gastroenterol Dietol, 1 Antimicrob Agents Ch, 1 322. Heart Surg Forum, 1 J Clin Periodontol, 1 323. 324. Breast, 1 Breast, 1 Int J Legal Med, 1 Maturitas, 1 J Eur Acad Dermatol, 1 325. 326. 327. J Eur Acad Dermatol, 1 Luminescence, 1 Expert Opin Drug Saf, 1 Gynecol Oncol, 1 Graef Arch Clin Exp, 1 Percept Mot Skills, 1 Percept Mot Skills, 1 Percept Mot Skills, 1 Ned Tijdschr Geneeskd, 1 Int J Clin Pract, 1 Nephrologie, 1 Bmc Pregnancy Childbirth, 1 J Vet Med A, 1 Ann Transplant, 1 Chem Rev, 1 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. Chem Rev, 1 Microbiol Res, 1 343. Metab Eng, 1 344. Hepato-gastroenterol, 1 345. Vox Sang, 1 Biosens Bioelectron, 1 346. 347. 348. Biomed Chromatogr, 1 J Pharmaceut Biomed, 1 J Pharmaceut Biomer Chaos, 1 J Paediatr Child H, 1 Am J Hematol, 1 Chronic Dis Can, 1 Vet Microbiol, 1 J Renal Nutr, 1 Hosp Q, 1 Nahrung, 1 Haemophilia, 1 Anal Sci, 1 Exp Appl Acarol, 1 Nephron, 1 349 350 351 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. Nephron, 1 Inorg Chem, 1 Asklepii, 1 Acta Crystallogr C, 1 364. Water Res, 1 Behav Modif, 1 365. 366. Int J Emerg Ment Health, 1 Soins Pediatr Pueric, 1 367. Health Care Food Nutr Focus, 1 Eur J Orthodont, 1 368. 369. Eur J Orthodont, 1 Brit J Nutr, 1 J Anim Sci, 1 Med Hypotheses, 1 Can J Microbiol, 1 J Hypertens, 1 Diabetes Metab, 1 370. 371. 372. 372 373 374 375 376 Diabetes Metab, 1 Cancer, 1 Rech Soins Infirm, 1 Am J Nephrol, 1 Am J Obstet Gynecol, 1 377 378 379 380. 381. Contracept Fertil Sex, 1 J Am Soc Nephrol, 1 382. Contrib Nephrol, 1 383. 384. Int J Radiat Oncol, 1 Ann Chir Gynaecol, 1 385. J Biol Chem, 1 386. Arch Fr Pediatr, 1 387. Brit J Haematol. 388. Bull Mem Acad R Med Belg, 1 389. 390. Hum Genet, 1 Hum Mol Genet, 1 Hum Mol Genet, 1 Drug Alcohol Depen, 1 J Mal Vascul, 1 Jugosl Ginekol Perinatol, 1 J Assoc Physicians India, 1 Stomatol Glas Sth, 1 Acta Stomatol Croat, 1 Ann Pathol, 1 B Acad Nat Med Paris, 1 Haematologica, 1 392. 393. 394. 395. 396. 397. 398. 399. 400. Haematologica, 1 Clin Ter, 1

default # fulltext, Macedonia (Republic), Methods, Hospitals, Hospitalization, Risk Factors, Surgery, Women, Syndrome, Arteries, and Kidney (in descendent order) (Table 2). On the top of twenty Macedonian authors who are included in PubMed are "Polenakovic M" (156 abstracts or 10.6% of the total number) and "Efremov G" (154 abstracts or 10.5% of the total number). The rest of the 18 authors are: "Tasic V", "Spasovski G", "Gucev Z" OR "Guchev Z", "Popov Z", "Ivanovski N", "Petrusevska G" OR "Petrushevska G", "Spiroski M" OR "Spirovski M", "Sikole A", "Stafilov Т", "Pop-Jordanova N",

391

"Cakalaroski K". "Dzikova S", "Kolevski P", L", "Grcevska L", "Kocarev "Georgievska-Ismail L", and "Petlickovski A" OR "Petlichkovski A". The top twenty Macedonian authors published 1063 papers indexed in PubMed or 72.4% of the total number of indexed abstracts (1469 abstracts) from the Republic of Macedonia (Table 3).

Table 2: Number of publications indexed in PubMed according to terms analysed with GoPubMed (1469 abstracts identified on March 18, 2013).

Top Terms	Publications
Humans	1,005
Patients	748
Adult	406
Middle Aged	370
Evaluation Studies as Topic	284
Diagnosis	253
Aged	213
Child	210
Adolescent	174
Unknown term default#fulltext	168
Macedonia (Republic)	142
Methods	132
Hospitals	118
Hospitalization	118
Risk Factors	118
Surgery	111
Women	109
Syndrome	104
Arteries	102
Kidney	101

The first indexation of an abstract from the Republic of Macedonia in PubMed, analysed with GoPubMed, was in the year 1987. There was a very slow increase of indexed abstracts/papers in the next eleven years (till 1998 year). A significant increase of abstracted papers was recorded during the period of 1989-2012 (from 50 abstracts to 180 abstracts, respectively) and a significant increase of relative research interest (from 0.00006% to 0.00018%, respectively). The relative increase for the period between 1989 and 2012 was 27.8% for the abstracts and 33.3% for the relative research interest (Fig. 2).

Table 3: Top twenty authors from the Republic of Macedonia according to abstracts indexed in PubMed semantically analysed with GoPubMed (1469 abstracts identified on March 18, 2013).

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Rank	Author	Number of PubMed Abstracts (%)
1	"Polenakovic M"	156 (10.6 %)
2	"Efremov G"	154 (10.5 %)
3	"Tasic V"	93 (6.3 %)
4	"Spasovski G"	79 (5.4 %)
5	"Gucev Z" OR "Guchev Z"	63 (4.3 %)
6	"Popov Z"	58 (3.9 %)
7	"Ivanovski N"	53 (3.6 %)
8	"Petrusevska G" OR "Petrushevska G"	52 (3.5 %)
9	"Spiroski M" OR "Spirovski M"	51 (3.5 %)
10	"Sikole A"	51 (3.5 %)
11	"Stafilov T"	40 (2.7 %)
12	"Pop-Jordanova N"	38 (2.6 %)
13	"Cakalaroski K"	36 (2.4 %)
14	"Dzikova S"	32 (2.2 %)
16	"Grcevska L"	30 (2.0 %)
17	"Kolevski P"	26 (1.8 %)
18	"Kocarev L"	26 (1.8 %)
19	"Georgievska-Ismail L"	25 (1.7 %)
20	"Petlickovski A" OR "Petlichkovski A"	23 (1.6 %)
Total number of abstracts		1063 (72.4 %)





Figure 2: Number of abstracts and relative research interest from the Republic of Macedonia indexed in PubMed database and semantically analyzed with GoPubMed (1469 abstracts identified on March 18, 2013).

Geographic distribution of the Macedonian authors affiliated with different parts of/countries in the world, whose papers have been indexed in the PubMed database and semantically analyzed with GoPubMed, revealed that they are mostly aggregated in Europe, North America and Japan (Fig. 3).



Figure 3: Geographic distribution of Macedonian authors affiliated with different countries in the world who have been indexed in PubMed database and semantically analyzed with GoPubMed (1469 abstracts identified on March 18, 2013).

Top author networks of the Macedonian scientists indexed in PubMed and semantically analysed with GoPubMed have shown several groups.



Figure 4: Author networks of Macedonian scientists who have been indexed in PubMed database and semantically analyzed with GoPubMed (1469 abstracts identified on March 18, 2013).

The largest group was composed of scientists working in the field of nephrology and related disciplines (Polenakovic M, Dzikova S, Sikole A, Spasovski G, Ivanovski N, Popov Z, Stojceva-Taneva O, Petrusevska G, Tasic V, Masin-Spasovska J, Stojkovski L, Lekovski L, Grcevska L, Cakalaroski K, Kolevski P, and Selim G). Several networks are composed of four authors: Spiroski M, Trajkov D, Labudovic D, and Todorova B; Efremov G, Plasevska D, Pop-Jordanova N, and Koceva S; Georgievska-Ismail L, Borozanov V, Vavlukis M, and Bosevski M; and Stafilov T, Zendelovska D, Stefova M, and Kulevanova S (Fig. 4).

Discussion

We present the semantic analysis of Macedonian medical-related documents indexed in the PubMed database with the GoPubMed. Macedonian medical scientists have published papers in a total of 400 different journals which have been indexed in PubMed database. The largest number of published papers was in the domestic journal Prilozi and the majority of terms used in the abstracts were humans, followed by patient, adults, and middle aged.

Two Macedonian authors whose papers are indexed in PubMed account for the largest number of included abstracts. These are "Polenakovic M" (156 abstracts or 10.6 % of the total number) and "Efremov G" (154 abstracts or 10.5 % of the total number). Top twenty Macedonian authors published 72.4% of the total number of abstracts indexed in PubMed. A significant increase of abstracted papers during the period of 1989-2012 was recorded. The relative increase during this period (1989-2012) was 27.8% for the abstracts and 33.3% for the relative research interest. Top author networks of the Macedonian scientists indexed in PubMed and semantically analyzed with GoPubMed have shown that the largest group was composed of scientists working in the field of nephrology and related disciplines and several other networks composed of four authors each.

The low number of abstracts in PubMed from the Republic Macedonia prior to 1989 could be a result of: (a) semantically unrecognized country term (Republic of Macedonia) before and immediately after secession from the Social Federal Republic of Yugoslavia; (b) a low number of Internet connections both individually and institutionally; (c) low pressure of the educational and scientific community to publish in the journals indexed in PubMed (Publish or Perish); and (d) permanent jobs of biomedical scientists independent of their scientific impact. Similar results have been obtained by analyzing Macedonian medical scientific papers in the Scopus database, where the number slowly, but steadily has increased and reached its plateau in the years 2008 and 2009 [14].

In spite of the long tradition of medical publishing in the Republic of Macedonia (Macedonian

Medical Review has been published regularly since 1946) and a relatively large number of journals [15], they have very limited scientific influence [16] mainly because they do not comply with the international publication standards. Macedonian biomedical scientists have published their papers in 160 journals indexed in Scopus database [14] and in 400 journals indexed in PubMed from which only one is a domestic journal (Macedonian Journal of Medical Sciences in Scopus and Prilozi in PubMed).

Masic I and Sivic S compared the ratio of using Medline in Bosnia and Herzegovina (B&H), with the basics for health education at biomedical faculties of five universities. The results showed that only 11.6% of professors use Facebook type of social network, 49.3% of them have a profile on BiomedExperts scientific social network and 79% have available articles in the largest biomedical database system for spreading medical information MEDLINE [17]. Our findings have shown that twenty biomedical scientists from the Republic of Macedonia have published 72.4% of the total number of abstracts indexed in PubMed from which one half are from the nephrology field and related disciplines. Prevalence of the scientists from the nephrology field can be seen more clearly from the top author networks of the Macedonian scientists indexed in PubMed, which is the largest group composed of scientists working in this field. This prevalence of scientists from the field of nephrology is also visible in the Scopus database where the biggest H-index of 10 for the period between 2007 and 2008 in the Republic of Macedonia is obtained for the nephrology subject category, followed by medicine (miscellaneous) with H-index of 7, hematology and endocrinology, diabetes and metabolism with H-index of 6, transplantation, oncology and pathology and forensic medicine with Hindex of 5 [18].

Several explanations can be offered with reference to predominance of the nephrology subject category in the biomedical sciences of the Republic of Macedonia, such as: long-standing tradition of scientific publishing; a very large international scientific network of Macedonian nephrologists; a very large number of kidney diseases in the Republic of Macedonia; a very big percentage of finances allocated for kidney diseases used from the Health insurance funds for the nephrology and similar. However, we should not underestimate the monopoly of nephrologists in the Macedonian scientific medical journals: the Editor-in-Chief of the most prominent journal Prilozi is a nephrology expert, the Editor-in-Chief of the Macedonian Medical Review is a nephrology expert, and the Editor-in-Chief of Vox Medici was nephrologists also. It has to be mentioned that currently the Vice Dean for Science at the Faculty of Medicine is also a nephrology expert. I hope that this situation will be changed in the near future.

Introduction of more strict criteria for submission and/or defense of Master of Science

(MSc) and Doctor of Philosophy (PhD) degrees at the Faculty of Medicine in Skopje in the 2000's, as well as more strict criteria for election of mentors for Doctor of Philosophy at the Ss Cyril and Methodius University of Skopje applied five years ago, have significantly increased the number of biomedical scientific papers published in foreign journals either indexed in Scopus [14] or in PubMed. The pressure of Publish or Perish on the Macedonian biomedical scientists should be continuous and increasing in the coming years.

In conclusion, I can say that a requirement for publication of at least one paper, which is to be indexed in PubMed prior to the Philosophy Doctor Degree defence at the Faculty of Medicine, Ss Cyril and Methodius University of Skopje, was a trigger for an increased number of publications indexed in PubMed in the last decade. A larger number of Macedonian medical journals should be indexed in PubMed in order to increase the impact of Macedonian medical scientists in the world.

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