

Worldwide Publication Trends of Drug Repurposing and Drug Repositioning in the Science of Medicine (2003-2022)

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RESEARCH ARTICLE

Worldwide Publication Trends of Drug Repurposing and Drug Repositioning in the Science of Medicine (2003-2022)

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ABSTRACT:

Background: Science of medicine in the post-genomic era has significantly enhanced the knowledge of human diseases. These advancements could shed light to the transition of these benefits into drug therapeutics. Drug repurposing is a strategy that plays a pivotal role to provide novel insights into disease biology and further drive drug discovery as the ultimate goal. Herein, the current study aimed to analyse the global trends of drug repurposing peer-review publications from 2003 until 2022. **Methods:** We retrieved 1.371 articles related to drug repurposing studies and used similar terms and keywords, including “drug repositioning”, “drug repurposing”, “drug reprofiling”, “drug reusing”, and “drug recycling”. **Results:** The number of drug repurposing publications has increased dramatically from 2003 through 2022. Besides, the most active country in publishing drug repurposing research is the United States, followed by China, India, the United Kingdom, and Italy, respectively. Meanwhile, the top five frequently used keywords are drug repurposing ($n = 336$), drug repositioning ($n = 335$), COVID-19 ($n = 134$), SARS-CoV-2 ($n = 135$), and molecular docking ($n = 67$). **Conclusions:** This study emphasizes the importance of conducting active research collaboration in drug repurposing and drug repositioning especially pertaining to the COVID-19 pandemic.

KEYWORDS: Drug repurposing, drug repositioning, drug discovery, drug reusing, molecular docking, bibliometric.

INTRODUCTION:

Developing new drugs from clinical trials to market is time-consuming and highly expensive in most therapeutic areas, estimated to be ~15 years and >US\$1 billion, respectively¹. More than 10.000 drugs undergoing clinical trials had been registered at www.clinicaltrials.gov, but only a few drug candidates made it to the next phase of clinical trials².

with around 5% of new molecules entering phase I clinical trial being approved by the United States of America (USA) Food and Drug Administration (FDA)³.

The dearth of these new clinically approved drugs has led to a new approach called drug repurposing as a promising strategy, which finds new uses for old drugs as usable therapeutic agents. Some advantages of drug repurposing are better understanding of drug safety, pharmacological mechanisms, and pharmacokinetic profiles⁴. Evidence revealed that old drugs are promisingly to be repurposed or reused for secondary indications⁵. Several examples of drug repurposing that

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have been clinically used, including aspirin and sildenafil. Aspirin was initially used for pain relief and is currently used for cardiovascular disease prevention⁶. Sildenafil which was originally indicated to treat high blood pressure, was later repurposed for erectile dysfunction⁷. These examples emphasize the promising insight of drug repurposing to identify new indications for various diseases treatments.

²⁴ The concept of drug repurposing also has been widely used for identifying new candidate drugs for the corona virus disease 2019 (COVID-19)⁸. Several drugs have been identified as emerging treatments of COVID-19 and recently are under clinical investigations, such as camostat mesylate [NCT04524663]⁸, lopinavir [NCT04376814], oseltamivir [NCT04558463], and ritonavir [NCT04345276]⁹. The aforementioned reasons prove that drug repurposing has paved the way as a promising strategy to explore drug discovery faster, especially in the emerging pandemic. Drug repurposing is referred to use old drug for new indication¹⁰, this term often interchangeable with the drug repositioning or drug reprofiling or drug reusing⁹ or drug recycling¹¹. Every year, an increasing number of scientific publications related to the drug repurposing were published and the trend seems increasing dramatically. Therefore, it is of relevance to identify the trend of studies and publications related to the drug repurposing.

Bibliometric analysis has been a well method for quantitative evaluation of research articles including authors of each article, the journal where it was published, and the number of citations of these journals. The bibliometric analysis shed light the research activities through quantitative description of literature¹². Some of the bibliometric analysis were published in many areas of research, including schizophrenia¹³, malaria¹⁴ and cancers^{15,16}. However, there were limited bibliometric analysis regarding the trend of drug repurposing and its similar terms. Therefore, the current study aims to evaluate and map the worldwide publications focused on the drug repurposing which were published through peer-review journals. Taken together, the ultimate goal of this study also provides the crucial information of the quantitative analysis of international publications related to drug repurposing and evaluates the research trend of drug repurposing publication mapping in each country.

Methods:

Study Design:

The current study used bibliometric analysis to identify the pattern and visualize the trend ¹² drug repurposing studies worldwide. We also used Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart for identifying the searching

strategy and filtering the sources of the articles, as shown in the Supplementary Figure 1¹⁴. This study involved no human's participation; therefore, the review board approval was not a mandatory for conducting this study.

Data search and identification:

In this study, articles were obtained from the Scopus database accessed on 27/10/2021. Articles which were published from 2003 to 2022 are included in the data set for analysis. We excluded the articles that considered as proceedings, editorial materials, book chapters, abstract conferences, and reviews. Scopus database consists of many international peer-review, scientific journals with a high reputation for maintaining the quality of the articles. Therefore, this study data set was valid in representing the quality of the publication. We used some keywords and Boolean operator "OR" to gather the search, including Drug repositioning OR Drug repurposing OR Drug Reprofiling OR Drug reusing OR Drug recycling were applied to identify articles that matched this study objective.

Data extraction:

Peer-reviewed articles that are relevant to the keywords of this study were identified. The authors independently determined 1.371 articles to analyze their bibliometrics, and explored the relationships and research trends in the field of utilizing old drugs for the new indication.

Statistical analysis:

Bibliometric analysis is a method to analyze relevant literature through mathematic and statistic approaches and visualize ⁵ graphical representation of bibliometric maps. We used VOSViewer version 1.6.16 (Universiteit ⁵ iden, The Netherland)¹⁷ dan Biblioshiny R package¹⁷ to build data matrices through individual bibliographic and to visualize the bibliometric networks based on citation, bibliographic coupling and conformity, and authorship relations.

RESULTS:

Total number of retrieved article and growth of drug repurposing publications:

We retrieved 2.292 articles which were published between 2003 to 2022. All articles were associated with drug repurposing and its synonym that often been used in the scientific field, including drug repositioning, drug reprofiling, drug reusing, and drug recycling. After extracting articles, we obtained 1.371 articles that met the inclusion criteria and 921 documents were excluded (Supplementary Figure 1).

According to the findings, the term "drug repurposing" came from an article published in the journal AIDS, with the title "Latino drug-recycling group distributes

hope in a bottle and an activist spirit” in 2003¹⁸. Based on this article, the term of drug-recycling was used as synonymous of drug repurposing term for the first time. While the term of drug repositioning in the original article started to be used in 2006. Li YY *et al.*, wrote the article with title “A large-scale computational approach to drug repositioning” which was applied in the computational approaches for identifying potential novel therapeutic by utilizing existing drugs for drug repositioning¹⁹. Since 2006, the term of drug repositioning and drug repurposing have been commonly used in the scientific literatures and publications.

The annual number of publications with regards to drug repurposing in the early of 2000 until 2012 is less than 20 documents, and has been rising dramatically from early 2013 till 2022 (Figure 1A). While as depicted in the Figure 1B, upcoming topic research related to drug repurposing were visualized in Figure 1B. According to the network visualization by mapping the occurrence terms in the title, abstract and keywords, we therefore identified four clusters indicated five most-frequently used topics in the publications related to drug repurposing. The topics include drug repurposing (blue), drug repositioning (green), COVID-19 (yellow), SARS-CoV-2 (yellow), and molecular docking (bright green).

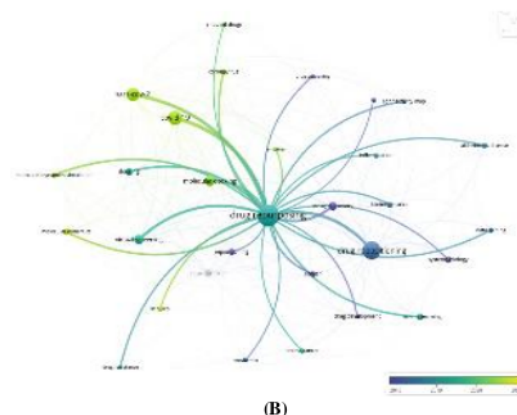
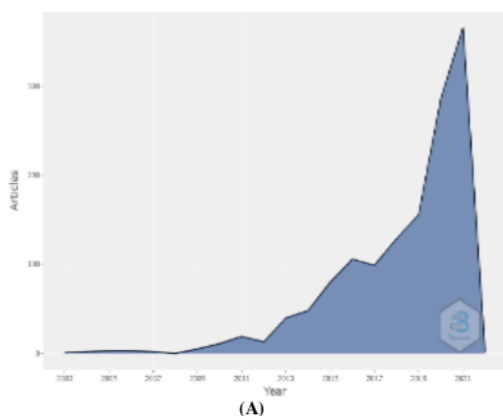


Figure 1. (A) Annual growth of drug repurposing publications. (B) Network visualization map of author keywords in the drug repurposing literature (2003–2022). Topics include drug repurposing (blue), drug repositioning (green), COVID-19 (yellow), SARS-CoV-2 (yellow), and molecular docking (bright green).

Most cited documents related to drug repurposing:

From a total of 1,371 articles that met the eligibility, we highlighted top 10 articles with the highest citation, as shown in Table 1. Top two articles with the highest citation had been published in *Nature* (Impact Factor 2020 =49.962) and *Cell Discovery* (Impact Factor 2020 =10.849) journals, and these two articles were related with the COVID-19. The title of first highest citation was “A SARS-CoV-2 protein interaction map reveals targets for drug repurposing” with total amount of citations around 1,324 at the time of this article were published^[20]. The second article with the title “Network-based drug repurposing for novel coronavirus 2019-nCoV/SARS-CoV-2” reached a total amount of 642 citations on November 26th 2021^[21]. Among top 10 articles, we found that most of articles were published in the high impact factor journals and high-quality grades and they were listed in the Scimago Journal Rank (SJR) journal quartile one.

Table 1: Top 10 cited publications in the field of drug repurposing research in 2003-2022

S.No	Publication Title	Year	Journal Name	Number of Citation*	Reference
1	A SARS-CoV-2 protein interaction map reveals targets for drug repurposing	2020	Nature	1324	20
2	Network-based drug repurposing for novel coronavirus 2019-nCoV/SARS-CoV-2	2020	Cell Discovery	642	21
3	Discovery of drug mode of action and drug repositioning from transcriptional responses	2010	PNAS	538	49
4	Prediction of drug-target interactions and drug repositioning network-based inference	2012	PLoS Computational Biology	530	50
5	Identification of small-molecule inhibitors of Zika virus infection and induced neural cell death via a drug repurposing screen	2016	Nature Medicine	402	51

6	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000	2014	Antimicrobial Agents and Chemotherapy	369	52
7	Exploiting drug-disease relationships for computational drug repositioning	2011	Briefings in Bioinformatics	311	53
8	Consequences of treated water recycling as regards pharmaceuticals and drugs in surface and ground waters of a medium-sized Mediterranean catchment	2006	Environmental Science and Technology	257	54
9	A survey of current trends in computational drug repositioning	2016	Briefings in Bioinformatics	255	55
10	Auranofin: Repurposing an Old Drug for a Golden New Age	2015	Drugs in R and D	245	56

*Number of citations up to 2021

Country Collaboration related with the drug repurposing study:

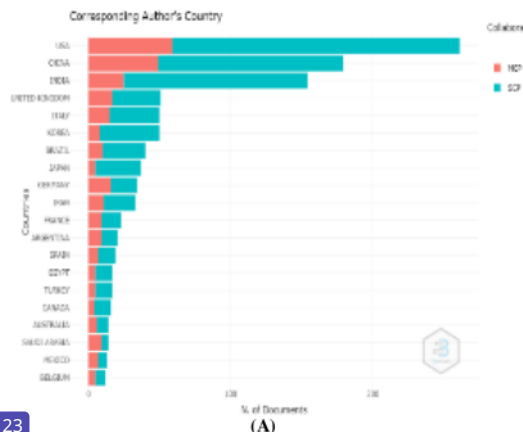
It is important that the collaboration among authors for publishing scientific articles be encouraged especially in the academic field. The science will be widely beneficial especially when altogether done in large, collaborative teams. The collaboration entails communication, which indicated that the authors collaborate internationally to increase the benefit of sciences.

We analysed the single country collaboration (SCP) and multiple countries collaboration (MCP), resulting in top 5 countries subsequently with highest SCP and MCP, including USA, China, India, UK, and Italy (Figure 2A and 2B). The United States published 261 articles (59 MCP; 202 SCP), followed by China with 179 publications (49 MCP; 130 SCP). India published 154 articles (25 MCP; 129 SCP), the United Kingdom published 51 articles (17 MCP and 34 SCP), and the last country, Italy, published 50 articles (15 MCP; 34 SCP) (Table 2).

Table 2. Countries with highest active collaboration related to drug repurposing publications from 2003 to 2022

Country	Article	Frequency	SCP	MCP	MCP Ratio
USA	261	0.218045	202	59	0.22
CHINA	179	0.149541	130	49	0.27
INDIA	154	0.128655	129	25	0.16
UNITED KINGDOM	51	0.042607	34	17	0.33
ITALY	50	0.041771	35	15	0.30
KOREA	50	0.041771	42	8	0.16
BRAZIL	40	0.033417	30	10	0.25
JAPAN	37	0.030911	32	5	0.13
GERMANY	34	0.028404	18	16	0.47
IRAN	33	0.027569	22	11	0.33
FRANCE	23	0.019215	14	9	0.39
ARGENTINA	21	0.017544	12	9	0.42
SPAIN	19	0.015873	12	7	0.36
EGYPT	17	0.014202	12	5	0.29
TURKEY	17	0.014202	12	5	0.29
CANADA	16	0.013367	12	4	0.25
AUSTRALIA	14	0.011696	8	6	0.42
SAUDI ARABIA	14	0.011696	5	9	0.64
MEXICO	13	0.010860	6	7	0.53
36 BELGIUM	12	0.010025	7	5	0.41

SCP: Single Country Publication, MCP: Multiple Countries Publication



23 MCP: Multiple Country Publication SCP: Single Country Publication



28 Figure 2. Countries with active collaboration in drug repurposing research from 2003 through 2022. (A) Most active, collaborative countries and their international collaboration in drug repurposing research, presented by SCP and MCP. (SCP; Single Country Publication, MCP; Multiple Countries Publication). (B) Frequency of research collaboration among countries related to drug repurposing studies,

Analysis of country collaborations (SCP and MCP) are beneficial as alternative information for researchers, especially new researchers to determine international research networks. The detailed frequency of each country in their collaboration with other countries is depicted in Table 3. It shows that the USA and China

collaborated in research 55 times -- it was considered as the most active country collaboration, the 31 followed by 30 times research collaboration between USA and the UK. Indicated the number of collaborations among authors between two countries (USA-China) was higher than that of two other countries (USA-UK).

Table 3. The most active countries and their international collaborators

Country Name	Collaborator	Frequency
USA	China	55
USA	United kingdom	30
UNITED KINGDOM	Belgium	14
USA	Germany	14
USA	France	13
USA	India	13
UNITED KINGDOM	Germany	12
USA	Belgium	12
CHINA	Hong kong	11
USA	Canada	10
SAUDI ARABIA	Pakistan	8
UNITED KINGDOM	Italy	8
CHINA	United kingdom	7
USA	Switzerland	7
CHINA	Singapore	6
INDIA	Germany	6
INDIA	Saudi arabia	6
USA	Australia	6

Geographical distribution of drug repurposing 11 long countries:

The geographical distribution of the retrieved documents is presented in Figure 3. Publications in the field of drug repurposing were vary across countries, resulted that drug repurposing research and publication was led by the USA. In addition, the USA was considered as the country with the highest citation 8 compared to other countries (Figure 3A). Instead of the highest number of publications, it is shown that India is more actively involved in conducting research collaboration with other countries than the USA in 2021, as shown with yellow colour in Figure 3B.

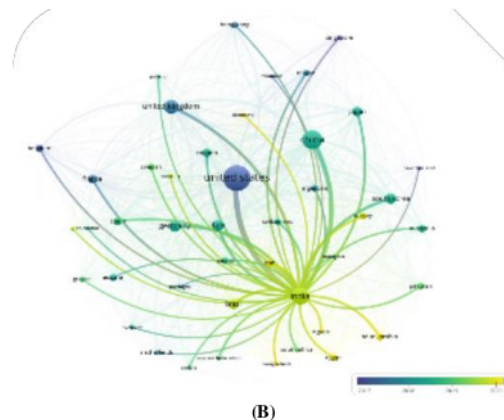
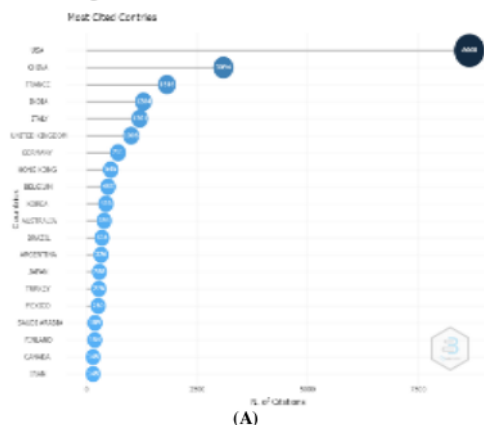


Figure 3. (A). Most cited countries related to drug repurposing publications (B). Network visualisation map of drug repurposing research (2003–2022); top 5 active countries in publishing drug repurposing research

The trend of using keywords related to drug repurposing

Keywords are the cornerstone to search intended studies in various databases. One aim of using appropriate keywords is to help researchers obtain articles that are related to the topic of their study [22]. It means that appropriate keywords are essential to gather relevant information in the field of drug repurposing. The popular keywords of drug repurposing publication and drug repurposing related to the current field is presented in Table 4.

Table 4. The most-frequently used keywords in drug repurposing publications

Terms	Frequency
Drug repurposing	336
Drug repositioning	235
COVID-19	134
SARS-CoV-2	115
Molecular docking	67
Virtual screening	54
Repurposing	48
Drug discovery	46
Docking	34
Molecular dynamics	25
Repositioning	24
Machine learning	23
Systems biology	23
Cancer	21
Bioinformatics	19
Coronavirus	19
Molecular dynamics simulation	16
Alzheimer's disease	15
Data mining	14
Drug development	14
Inflammation	14
Breast cancer	13
Connectivity map	13
In silico	13
Antiviral drugs	12

According to this analysis, we respectively determined that the most popular keywords are drug repurposing (n=336), drug repositioning (235), COVID-19 (n=134), SARS-CoV2 (n=115), and molecular docking (n=67) (Figure 4A and 4B).

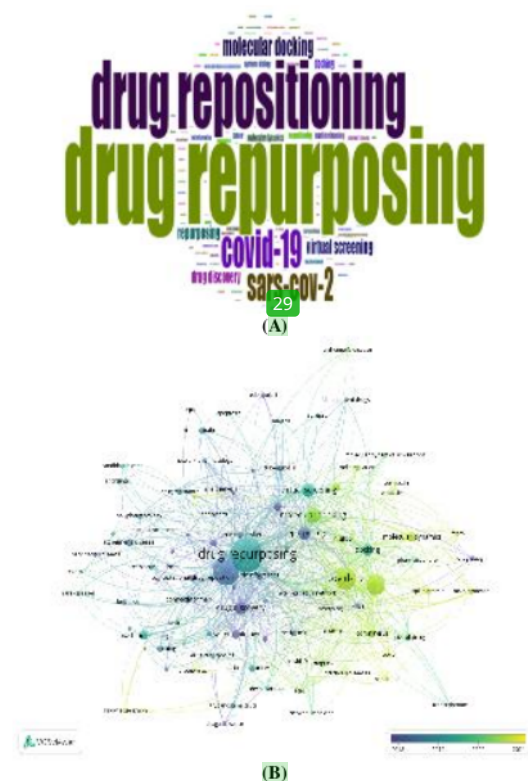


Figure 4. (A) Word cloud analysis of the most used keywords in drug repurposing publications (B) Overlay visualization of drug repurposing research related with the current field. Bigger blot represents higher number of publications.

DISCUSSION:

Drug repurposing and drug repositioning are two similar concepts of using old drug for a new indication¹¹. These two terms have been a trend in the science medicine literatures since 2003. No articles regarding drug repurposing were found before 2003. Number of articles have begun to escalate since 2003 and reached its peak in 2020. Drug repurposing in science of medicine growing rapidly through utilizing several approaches such as molecular docking for various diseases²³⁻²⁷ and data mining-based approach²⁸. Besides, it has been assumed that the peak of published articles might be particularly associated with abundant clinical studies to find new drug candidate for the COVID-19. The purpose of recent study was to identify the trends of drug repurposing publication worldwide. To achieve our aim, we used bibliometric analysis using selected keywords,

country publication related to drug repurposing, including countries with the most productive in drug repurposing researches, as well as the annual number of publications.

The result of current study leads to significant insights related to drug repurposing publications. We identified the trend of drug repurposing publications have elevated dramatically every year, particularly from a period of 2013 to 2020 with the highest number of publications was attained in 2020. It is surprising that in the early of 2020 the COVID-19 outbreak pandemic was confirmed and it was becoming a major international concern related with impacted the global health status²⁹. These pandemic leads scientists to focus finding, exploring, and developing drugs against the SARS-CoV-2³⁰. Due to these reasons, the pattern of publication related to drug repurposing in 2020 was prominent concern on utilizing old drug as a new indication for the COVID-19 treatment. In addition, the findings presented the trend of using drug repurposing approach to identify new drug against the COVID-19. The COVID-19 pandemic has not yet alleviated as no recent specific medications are available. When this occurs continuously, the situation can become worse including to mental health^{31,32}. It is currently still under clinical investigation and conventional repositioned drugs an alternative treatment of COVID-19³³. According to the visualization in Figure 4, we noticed that the drug repurposing was not only related to the COVID-19, but also some other target proteins have been identified, such as TMPRSS2³⁴, ACE-235, ph³³chemical Inhibitors³⁶ and antibiotic drugs against the papain like protease of SARS-CoV-2³⁷. Some other drugs are still under clinical investigation, including ivermectin^{38, 39} and remdesivir, the latter has been approved to be an emergency treatment against the COVID-19 [40]. This recent finding emphasized that drug repurposing-based approach has been widely used for identifying new candidate drug for treatment of the COVID-19.

The USA is considered as the country with the highest citation that contributed to the field of drug repurposing research. Potential reasons might be influenced by the USA active international collaboration in research and science. In addition, the USA leads fundamental medical research or experimental trials worldwide, supported by abundant funds and resources, policies, advanced technologies, and high-qualified researchers⁴¹. In fact, two articles with the highest number of citations were published in *Nature* and *Cell Discovery* in 2020, and these two articles were objectively exploring the candidates of new drug for the COVID-19 treatment^{20,21}. There is still an urgent need of finding new drugs and utilizing old drug against COVID-19 might be considered as an alternative so far that primary treatment

is currently symptomatic⁴². Most of publishers intended to call researchers to publish their research regarding the new drug discovery against the SARS-CoV-2, and provide them free access in the special issues⁴³.

Our analysis revealed that USA was not only the most active country in the publication of drug repurposing studies, but also the most frequent country with international collaboration. International collaboration is highly recommended for advance science and its implementation throughout the world^{44, 45}. As revealed by Savage *et al.*, (2018), collaboration is the key of cancer research, nowadays finding the new drug candidate to combat the COVID-19 is an emerging issue^{43,46}. All scientists are in a rush to synergize together in the involvement of the COVID-19 research. Collaboration is not only enhancing productivity of researchers but also can accelerate the output of finding. Several funding schemes has been provided by the international institutions to link research groups across countries^{47,48}.

STRENGTH AND LIMITATIONS:

Bibliometric visual analysis for drug repurposing provides an insight driven drug discovery for the COVID-19 treatment. Current citation and upcoming topics showed that the drug repurposing was reliable for identifying new drug candidate against COVID-19. Our bibliometric analysis used Scopus database. Although Scopus database is one of the largest databases in scientific field and provides high validity of each article, however, this study still has some limitations, such as bias toward English journals, publications from several developing countries that might published in non-English, and the journals that not indexed in Scopus.

IMPLICATION AND FURTHER STUDY:

This bibliometric analysis only represents the initial phase of drug repurposing study, nevertheless this study may bring a new light on the paramount progress of drug repurposing research, especially the drug discovery for the COVID-19 treatment. A systematic review and meta-analysis of randomized clinical trials that implement old drugs against COVID-19 is highly needed to provide important information to the healthcare providers and stakeholders in the clinical practice.

CONCLUSION:

Drug repurposing has been widely used in discovering and developing new drugs for emerging diseases. It reminds signal of the continuing research development. We concluded that the most active country in collaborating research worldwide and publishing articles reached the highest number of citations in the field of drug repurposing. The USA actively and aggressively

conducting research using drug repurposing approach to combat the COVID-19 pandemic. It is foreseeable that drug repurposing approach could be further explored to find new therapeutic agents and it is presumably implemented for further outbreak in the clinical practices.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE:

No ethical approval was required, as this was a bibliometric review for the existing literature.

AVAILABILITY OF DATA AND MATERIALS:

This study analysed the dataset from publicly available dataset. The source of this study can be accessed here <https://www.scopus.com/results>

COMPETING INTERESTS:

The authors disclose no conflict

34

AUTHORS' CONTRIBUTIONS:

LMI and ZN conceived and designed the study. LMI and ZN performed all data analyses. LMI, ZN, DAP, YRN, WA, HD, RM, MAS and C interpreted the results and revised the paper. LMI wrote the manuscript. All authors read and approved the final manuscript.

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