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Global Trends in Loop Mediated Isothermal Applications in Poor Resource Countries

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Abstracts

Loop-mediated isothermal amplification (LAMP) has been employed in various research studies range from point of care in detection and identification of pathogens, including viruses, bacteria, fungi and parasites. It is a relatively simple and low-cost technique compared to traditional polymerase chain reaction (PCR) methods. These advantages make LAMP a useful tool for pathogens detection and research, particularly in poor resource countries. The objective of this study was to assess the global trend in LAMP applications in poor resource countries. We investigated bibliometric data on LAMP Applications research published in PUBMED from October 20th, 2004, to October 20th, 2024. The selected study period was based on the areas that all research related to in the globe. The search was conducted on April 2, 2025. Utilizing advanced search features in PUBMED, we employed “MESH” terms for “Loop mediated Isothermal Amplification Applications” and “LAMP Applications” and incorporated the following keywords [Title/Abstract]: “Poor resource countries” or “Rich resource countries” or “Low-income economic countries” or “High income economic countries” and “Worldwide”. The high productive countries were found in Japan 103 (11.8%), followed by United States of America 100 (11.4%), China 69 (7.9%), Iran 61(6.9%), United Kingdom 52 (5.9%), and the least was observed in Africa. The Infectious diseases research collaboration, Kampala, Uganda emerged as the leading institution (n= 28), followed by the Department of Clinical Laboratory Medicine, the third affiliated hospital of Guangzhou Medical University, Guangzhou China (n= 12), and Makerere University College of Health Sciences, Kampala, Uganda (n=8) respectively. The leading first-third authors in LAMP Applications research include

Sugimoto, Chihiro (n = 10); Namangala, Boniface (n=9) and Dorsey, Grant (n=9). Although, Dorsey, Grant (from Joint University of California San Francisco, San Francisco) held the 2nd position for the most productive author based on principal author analysis (n=9) and ranked as the 1st most collaborative author (n = 42), while Sugimoto, Chihiro secured the 2nd highest total link strength (n= 41). The hotspot analysis of author keywords include: Nucleic Acid Amplification Techniques explored bacterial and fungal diseases; viral related diseases; Malarial parasites; food contamination and bacterial zoonotic diseases and trematodes and helminth diseases. The prevalence rate of publications on LAMP applications is higher among rich resource countries and lower among poor resource countries. The lower prevalence rate of publication output on LAMP application research among poor resource countries can be attributed to insufficient financial resources that can hinder research initiatives, equipment purchases, and personnel hiring. Poor resource countries might have restricted access to scientific literature, databases, and collaborations.

Keywords: Global Trends, Loop Mediated Isothermal Applications, Poor Resource Countries

Introduction

Loop-mediated isothermal amplification (LAMP) is a molecular biology technique used for amplifying DNA sequences (Febrer-Sendra *et al.*, 2023). In Africa, LAMP has been applied in various research studies to detect and identify pathogens, including viruses, bacteria, and parasites (Notomi *et al.*, 2000). LAMP has been used to detect malaria parasites in Africa, particularly in areas where the disease is endemic (Mori and Notomi, 2009). A study in Nigeria used LAMP to detect Plasmodium

falciparum in blood samples, with a sensitivity of 95.6% and specificity of 98.5% (Polley *et al.*, 2020). Malaria is a significant public health problem in many tropical and subtropical regions of the world (Febrer-Sendra *et al.*, 2023). Loop-mediated isothermal amplification (LAMP) is a molecular biology technique that has been used to detect malaria parasites in various research studies (Notomi *et al.*, 2000). This technique has several advantages over traditional PCR methods, including rapid results, high sensitivity, and specificity (Mori and Notomi, 2009; Simon *et al.*, 2021).

LAMP has been used to detect malaria parasites in various studies (Lau *et al.*, 2020; Polley *et al.*, 2020). LAMP is highly sensitive and specific in detecting malaria parasites, with a sensitivity of 95.6% and specificity of 98.5% reported in previous studies (Notomi *et al.*, 2000; Mori and Notomi, 2009; Polley *et al.*, 2020; Zhang *et al.*, 2022). LAMP is a relatively simple and low-cost technique compared to traditional PCR methods (Njiru, 2012). Despite its advantages, LAMP has several challenges and limitations in malaria research, including: Limited availability of LAMP equipment and reagents in some regions (Febrer-Sendra *et al.*, 2023); Need for specialized training and expertise in molecular biology techniques (Mori and Notomi, 2009); Potential for contamination and false positives (Mori and Notomi, 2009). LAMP is a useful tool for malaria research, particularly in resource-poor settings. Its rapid results, high sensitivity, and specificity make it an ideal technique for detecting malaria parasites.

LAMP has been used to detect Mycobacterium tuberculosis in Africa, particularly in areas with high prevalence of the disease (Bi *et al.*, 2012). A study in South Africa used LAMP to detect M. tuberculosis in sputum samples, with a sensitivity of 92.5% and specificity of 97.5% (15). Tuberculosis (TB) is a significant public health problem in many poor resource countries (Bi *et al.*, 2012; Mishra *et al.*, 2018). Loop-mediated isothermal amplification (LAMP) is a molecular biology technique that has been used to detect Mycobacterium tuberculosis in various research studies (Mishra *et al.*, 2018). This technique has several advantages over traditional PCR methods, including rapid results, high sensitivity, and specificity (Njiru, 2012). LAMP has been used to detect M. tuberculosis in various

studies, including: Detection of M. tuberculosis in sputum samples (Njiru, 2012); Detection of M. tuberculosis in tissue samples (Mishra *et al.*, 2018); Detection of multidrug-resistant TB (Mishra *et al.*, 2018; Liu *et al.*, 2021). LAMP has been shown to be highly sensitive and specific in detecting M. tuberculosis, with a sensitivity of 92.5% and specificity of 97.5% reported in some studies (Notomi *et al.*, 2000; Mori and Notomi, 2009; Zeng *et al.*, 2025). LAMP is a relatively simple and low-cost technique compared to traditional PCR methods (Njiru, 2012). There is limited availability of LAMP equipment and reagents in some regions (Bagcchi, 2023); it also requires the need for specialized training and expertise in molecular biology techniques (Mori and Notomi, 2009).

LAMP has been used to detect HIV in Africa, particularly in areas with limited access to advanced laboratory equipment (Njiru, 2012). A study in Kenya used LAMP to detect HIV-1 in blood samples, with a sensitivity of 96.2% and specificity of 98.1% (Ruang-Areerate *et al.*, 2021). Loop-mediated isothermal amplification (LAMP) is a molecular biology technique that has been used to detect HIV in various research studies (Ruang-Areerate *et al.*, 2021). This technique has several advantages over traditional PCR methods, including rapid results, high sensitivity, and specificity (Mori and Notomi, 2009). LAMP has been used to detect HIV in various studies, including: Detection of HIV-1 in blood samples (Curtis *et al.*, 2008); Detection of HIV-2 in blood samples (Ruang-Areerate *et al.*, 2021), Detection of HIV in infants and children. LAMP has been shown to be highly sensitive and specific in detecting HIV, with a sensitivity of 96.2% and specificity of 98.1% reported in numerous studies. LAMP has several advantages in HIV research, and such advantages make LAMP a useful tool for HIV diagnosis and research, particularly in poor resource countries. Despite its advantages, LAMP has several challenges and limitations in HIV research, including: Limited availability of LAMP equipment and reagents in some regions (Bagcchi, 2023), Potential for contamination and false positives (Mori and Notomi, 2009; Bagcchi, 2023).

Foodborne pathogens are a significant public health concern in many poor resource countries. A study in Ghana used LAMP to detect Salmonella in food samples,

with a sensitivity of 93.5% and specificity of 96.5% (Yang *et al.*, 2015). Loop-mediated isothermal amplification (LAMP) is a molecular biology technique that has been used to detect foodborne pathogens in various research studies (Notomi *et al.*, 2000). This technique has several advantages over traditional PCR methods, including rapid results, high sensitivity, and specificity (Mori and Notomi, 2009). LAMP has been used to detect various foodborne pathogens, including: Detection of *Salmonella* in food samples (Liu *et al.*, 2023); Detection of *E. coli* in food samples (Lee *et al.*, 2023); Detection of *Campylobacter* in food samples (Dong *et al.*, 2023). LAMP has been shown to be highly sensitive and specific in detecting foodborne pathogens, with a sensitivity of 93.5% and specificity of 96.5% reported in numerous studies (Wei *et al.*, 2018). LAMP is a relatively simple and low-cost technique compared to traditional PCR methods (Polley *et al.*, 2020). These advantages make LAMP a useful tool for foodborne pathogen detection and research, particularly in poor resource countries. Despite its advantages, LAMP has several challenges and limitations in foodborne pathogen research, these challenges and limitations need to be addressed in order to fully realize the potential of LAMP in foodborne pathogen research. LAMP has been used to detect waterborne pathogens in Africa, particularly in areas with limited access to safe water (Gordon *et al.*, 2023). A study in Ethiopia used LAMP to detect *E. coli* in water samples, with a sensitivity of 95.2% and specificity of 98.2% (Yinur *et al.*, 2023).

Waterborne pathogens are a significant public health concern in many poor resource countries (Yinur *et al.*, 2023). Loop-mediated isothermal amplification (LAMP) is a molecular biology technique that has been used to detect waterborne pathogens in various research studies (Notomi *et al.*, 2000). This technique has several advantages over traditional PCR methods, including rapid results, high sensitivity, and specificity (Mori and Notomi, 2009). LAMP has been used to detect various waterborne pathogens, including: Detection of *E. coli* in water samples (The *et al.*, 2023); Detection of *Salmonella* in water samples (Abdullah *et al.*, 2014); Detection of *Vibrio cholerae* in water samples (Yamazaki, 2021). LAMP has been shown to be highly sensitive and specific in detecting waterborne pathogens, with a sensitivity of 95.2% and specificity of 98.2% reported in one study (Yinur *et al.*, 2023).

LAMP has several advantages in waterborne pathogen research (Notomi *et al.*, 2000; Njiru, 2012; Gordon *et al.*, 2023). These advantages make LAMP a useful tool for waterborne pathogen detection and research, particularly in poor resource countries. These challenges and limitations need to be addressed in order to fully realize the potential of LAMP in waterborne pathogen research.

Loop-mediated isothermal amplification (LAMP) is a molecular technique used for detecting and amplifying DNA sequences. LAMP has gained popularity due to its simplicity, specificity, and sensitivity (Notomi *et al.*, 2000). LAMP's ease of implementation and rapid results make it an attractive alternative to PCR (Martineau *et al.*, 2017). The technique's applications span various fields, including diagnostics, food safety, and plant virology (28). A bibliometric analysis can provide insights into LAMP's research trends, authorship, and citation patterns (Notomi *et al.*, 2000; Panno *et al.*, 2020). The number of LAMP-related publications has been increasing steadily, indicating growing interest in the technique. Keyword analysis reveals frequently used terms such as "LAMP," "isothermal amplification," and "DNA detection". Co-citation analysis shows influential papers describing LAMP's development and applications (Parida *et al.*, 2008). This bibliometric analysis provides insights into LAMP's research trends, authorship, and citation patterns. The results highlight LAMP's growing popularity and its applications in various fields. Future research directions may focus on improving LAMP's performance, exploring new applications, and developing point-of-care diagnostics.

Method

We investigated bibliometric data on LAMP Applications research published in PUBMED from October 20th, 2004, to October 20th, 2024. The selected study period was based on the areas that all research related to in the globe.

The search was conducted on April 2, 2025. Utilizing advanced search features in PUBMED, we employed "MESH" terms for "Loop mediated Isothermal Amplification Applications" and "LAMP Applications" and incorporated the following keywords: "Poor resource countries" [Title/Abstract]

OR “Rich resource countries” [Title/Abstract] OR “Low income economic countries” [Title/Abstract] OR “High income economic countries” [Title/Abstract] AND “Worldwide” [Title/Abstract]. We retrieved all relevant data according to the pre-established search criteria without restrictions on the type of articles. The collected data were used to calculate bibliometric measures. Since PUBMED does not maintain citation records, we obtained citation details for authors and articles through Google Scholar.

Screening protocol and criteria

Only articles specifically addressing Loop mediated Isothermal Amplification Applications were considered for inclusion. Articles that mentioned loop mediated isothermal amplification without its applications were excluded. There were no limitations regarding the type of article accepted. Duplicate articles were also eliminated. Two separate review teams among the authors independently conducted the article selection. Any disagreements were resolved through consensus between both groups.

Visualization of social network analysis

We employed VOS viewer (Center for Science and Technology Studies, Leiden University, The Netherlands) version 1.6.18 to create a visual representation of “Loop mediated isothermal amplification applications, “globe”, terminology and collaboration based on the data obtained from PUBMED.

Impact factor

The impact factor (IF) serves as an indicator of a journal's influence and was first established by the Institute for Scientific Information in Philadelphia, PA, USA, as a bibliometric measure. It is refreshed yearly in the Journal Citation Report (JCR) published by Clarivate Analytics, and the figure is frequently seen as a sign of prestige. We referenced the JCR data from 2024.

Authors/Institution participations index

We assessed the total scientific publications from 2004 to 2024 related to “Loop mediated Isothermal Amplification applications”, “LAMP Application”. This reflects the count of documents authored by an individual or institution on the subject of LAMP Applications in the globe compared to the overall publications in that field.

Keyword analysis

We utilized keyword evaluation to confirm the trends of discussion and research regarding the “Loop mediated Isothermal Amplification Application”, “LAMP Application”, “globe”

Co-authorship analysis

Co-authorship signifies collaboration among authors who contribute to a specific area of research. The collaboration between authors can be observed through the co-authorship of publications (Yinur *et al.*, 2023). The co-authorship network diagram created by VOS viewers illustrates the collaborative social network within research domains.

Bibliometric mapping

Bibliometric mapping consists of two components: co-authorship mapping and co-occurrence mapping. Co-authorship highlights the collaborative efforts of authors within institutions contributing to the field of research, while co-occurrence emphasizes the relationships among keywords.

The visualization of co-authorship network analysis employs the following interpretative keys: The size of the nodes or bubbles (circles) in the network signifies the frequency or quantity of documents associated with an author or institution. Furthermore, the lines or arcs connecting nodes represent the existence and strength of the co-authorship relationship. Lastly, the color of the node is determined by the VOS viewer clustering algorithm, which assigns colors based on the calculated similarity measure among them. As a result, it can be concluded that nodes sharing the same color are interconnected. Moreover, the proximity of two (Notomi *et al.*, 2000) nodes indicates the closeness of their relationship.

Analysis of global trends in LAMP Applications with the highest publications

The prevalence rate of publications on LAMP applications Research and classification based on countries represented the highest productive outputs in Japan 103 (11.8%), United State of America 100 (11.4%), China 69 (7.9%), Iran 61 (6.9%), United Kingdom 52 (5.9%), India 51 (5.8%), Thailand 49 (5.6%), Germany 40 (4.6%), Canada 39 (4.5%), France 23 (2.6%), Argentina 22 (2.5%), Korea 18 (2.1%), Spain 18 (2.1%), Malaysia 18 (2.1%), Ethiopia 17 (1.9%), Switzerland 15 (1.7%), Philippines 13 (1.5%), Australia 12 (1.4%), California 12 (1.4%), Taiwan 12 (1.4%), Ireland 11

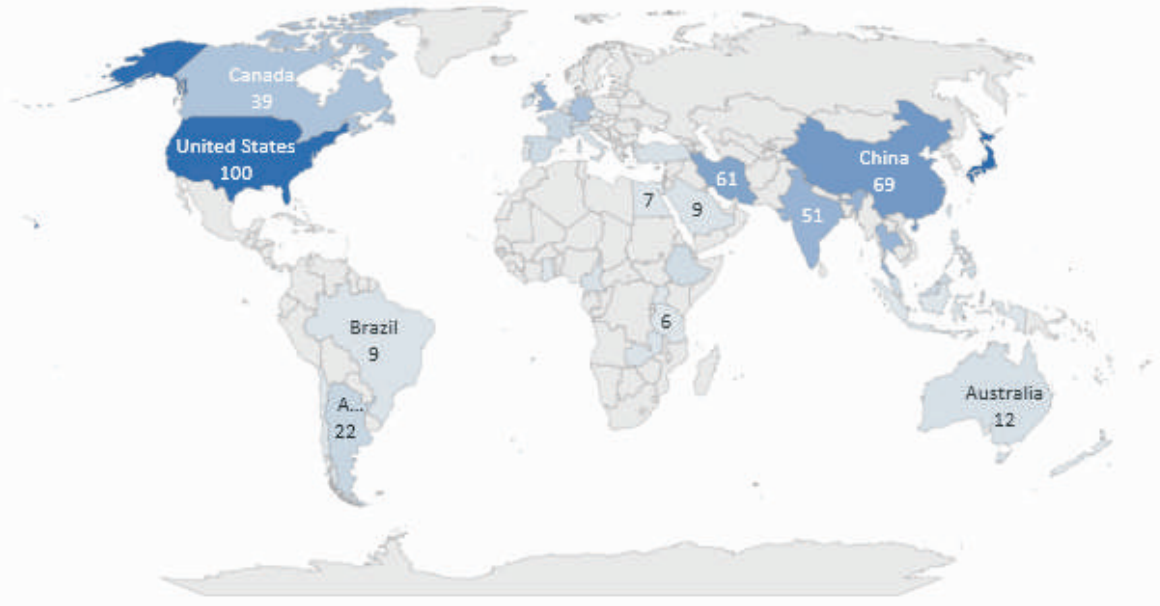
(1.3%), Cameroon 11 (1.3%), Italy 11 (1.3%), Turkey 11 (1.3%), Chinese 9 (1.0%), Saudi Arabia 9 (1.0%), Brazil 9 (1.0%), Zambia 9 (1.0%), Egypt 7 (0.8%), Czech

republic 7 (0.8%), Netherland 7 (0.8%), Tanzania 6 (0.7%), (Table 1) (Figure 1a and Figure 1b).

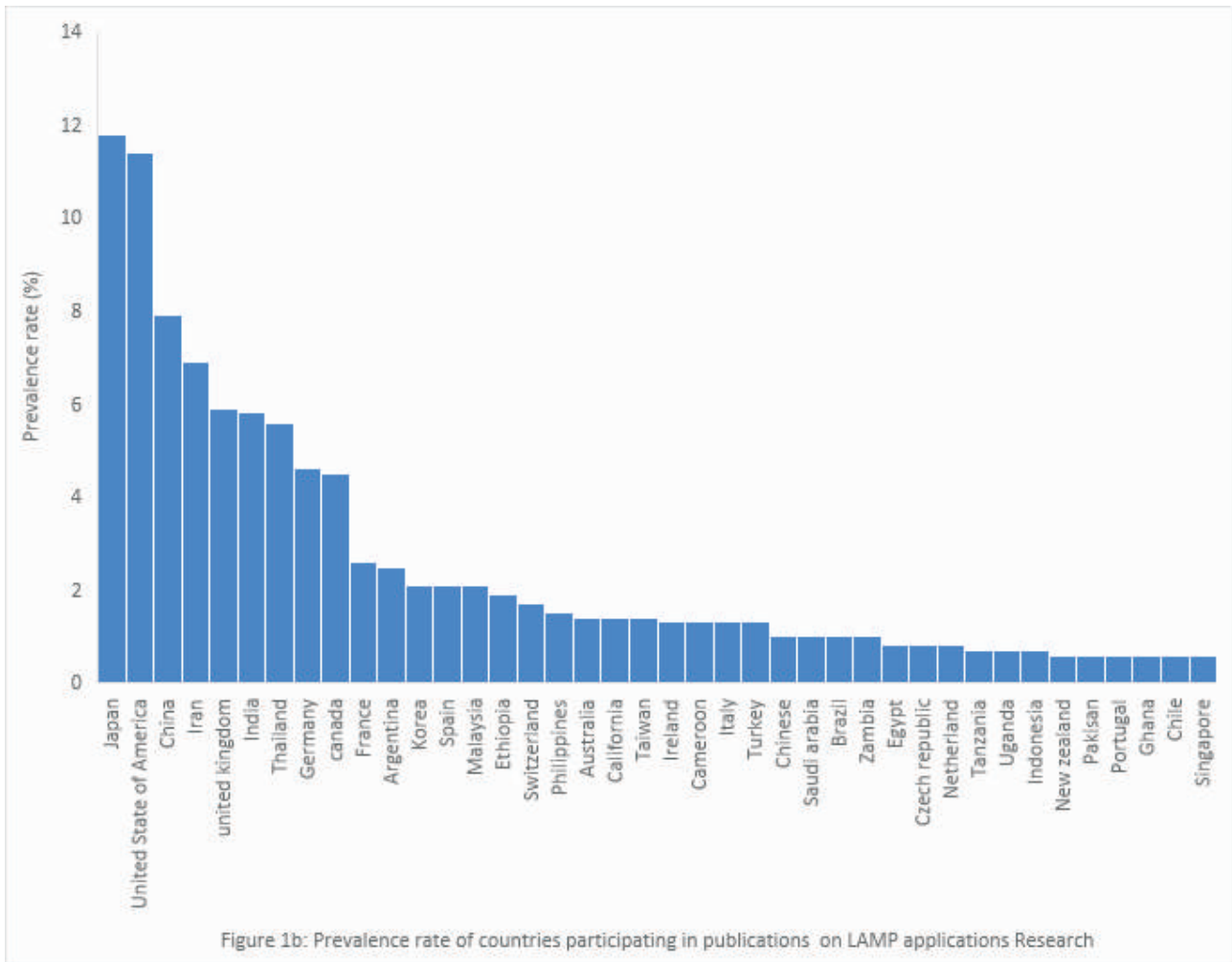
Table 1: Countries contributing to publications on LAMP Applications Research

Countries	Publications	Prevalence
Japan	103	11.8
United State of America	100	11.4
China	69	7.9
Iran	61	6.9
United Kingdom	52	5.9
India	51	5.8
Thailand	49	5.6
Germany	40	4.6
Canada	39	4.5
France	23	2.6
Argentina	22	2.5
Korea	18	2.1
Spain	18	2.1
Malaysia	18	2.1
Ethiopia	17	1.9
Switzerland	15	1.7
Philippines	13	1.5
Australia	12	1.4
California	12	1.4
Taiwan	12	1.4
Ireland	11	1.3
Cameroon	11	1.3
Italy	11	1.3
Turkey	11	1.3
Chinese	9	1.0
Saudi Arabia	9	1.0
Brazil	9	1.0
Zambia	9	1.0
Egypt	7	0.8
Czech republic	7	0.8
Netherland	7	0.8
Tanzania	6	0.7
Uganda	6	0.7
Indonesia	6	0.7
New Zealand	5	0.6
Pakistan	5	0.6
Portugal	5	0.6
Ghana	5	0.6
Chile	5	0.6
Singapore	5	0.6

Fig. 1a: Countries participating in the number of publications on LAMP Research

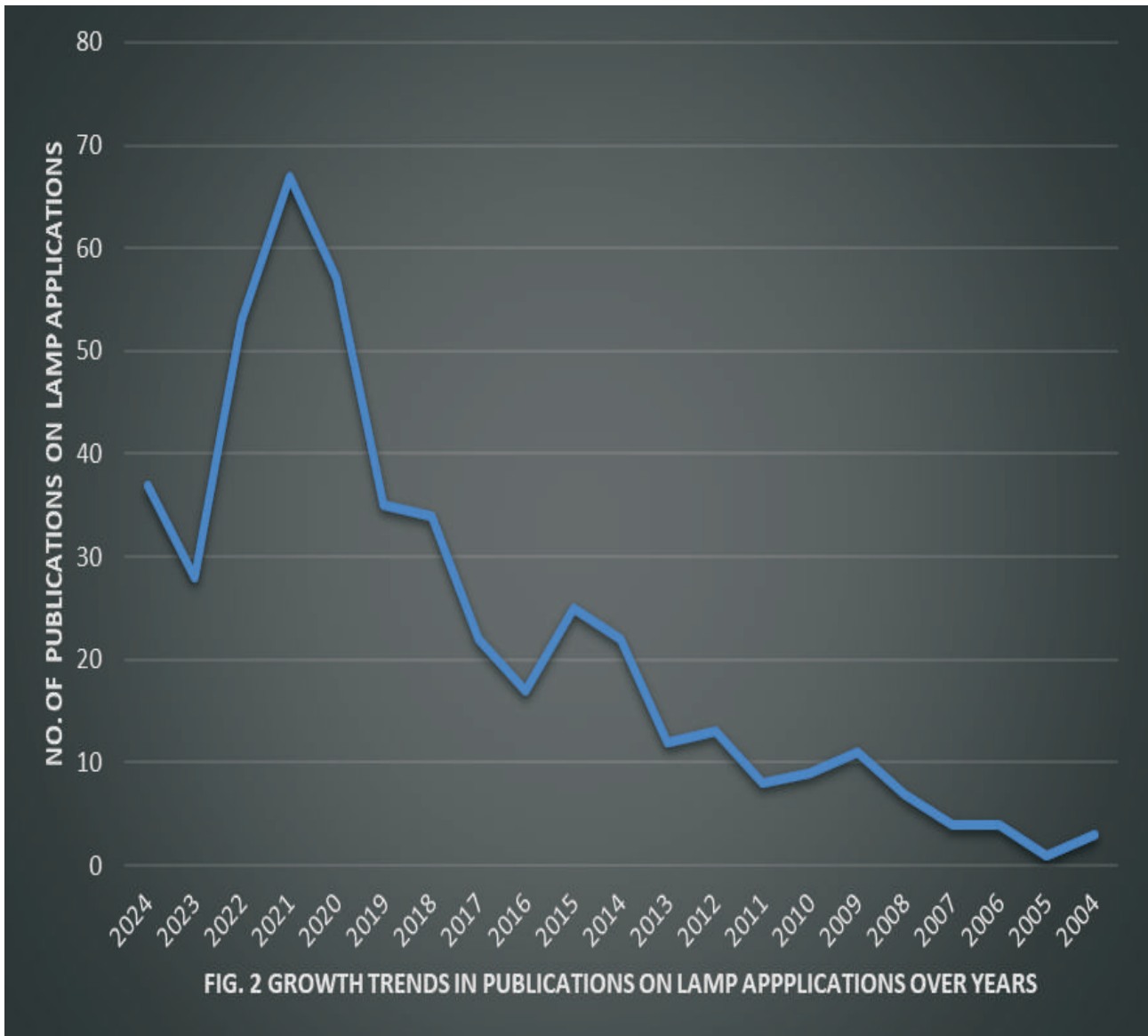


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The growth trend of LAMP applications articles shows fluctuations over the years. Initial growth (2006-2010) suggests growing interest and adoption of LAMP technology during this period. Drop in 2011 could be due to various factors, such as a shift in research focus, methodological challenges, or limited awareness about LAMP's potential. Recovery and sharp increase (2012-2016) indicate renewed interest, possibly driven by advancements in LAMP technology, increased awareness, or successful applications in various fields. Sharp drop in 2017 might be attributed to factors like changes in

research priorities, funding, or emerging competing technologies. Continued growth (2018-2022) show steady increase, culminating in a peak in 2022, suggesting sustained interest and potential maturation of LAMP applications, possibly due to its effectiveness, simplicity, or expanding applications. Some possible factors contributing to these trends include; improvements in LAMP methodology or instrumentation might have driven increased adoption. Research funding such as Changes in funding priorities or availability, could have influenced the number of LAMP-related articles.



The institutions worldwide with the highest productivity in LAMP Application Research. The Infectious diseases research collaboration, Kampala, Uganda emerged as the leading institution (n= 28), followed by the Department of Clinical Laboratory Medicine, the third affiliated hospital of Guangzhou Medical University, Guangzhou China (n= 12), and Makerere University College Of Health Sciences, Kampala, Uganda (n=8) respectively. The top three institutions alone accounted for over 10 % of the total publication output globally. It is important to note that the Infectious

diseases research collaboration, Kampala, Uganda emerged as the leading institution as well as, the third affiliated hospital of Guangzhou Medical University, Guangzhou China, are among the most productive institutions. Among the leading 15 institutions, there are three institutions presented in African nations and these include: Infectious diseases research collaboration, Kampala, Uganda; Makerere University College of Health Sciences, Kampala, Uganda; Foundation for Innovative New Diagnostics (FIND), Geneva, Switzerland (Table 2).

Table 2: Analysis of publications from sources with the most output

Participating Institutions	Countries	No. of publications (%)
Infectious Diseases Research Collaboration, Kampala,	Uganda	28 (37.8)
Department of Clinical Laboratory Medicine, the Third	China	12 (16.2)
Affiliated Hospital of Guangzhou Medical University,		
Guangzhou		
Makerere University College of Health Sciences, Kampala,	Uganda	8 (10.8)
Lorestan University of Medical Sciences, Khorramabad, Iran	Iran	3 (4.1)
Belfast Health and Social Care Trust, Belfast	United Kingdom	3 (4.1)
University of the West of England, Bristol,	United Kingdom	2 (2.7)
Department of Infectious Disease, the Fifth Affiliated Hospital	China	2 (2.7)
of Guangzhou Medical University, Guangzhou		
University of Hawaii at Manoa, Honolulu, Hi, Usa	USA	2 (2.7)
Department of Plant Pathology, Kansas State University,	USA	2 (2.7)
Manhattan, Ks		
Department of Plant Pathology, University of Georgia, Tifton,	USA	2 (2.7)
Ga		
Foundation For Innovative New Diagnostics (Find), Geneva	Switzerland	2 (2.7)
Center For Animal Disease Control, University Of Miyazaki,	Japan	2(2.7)
Miyazaki		
Center for Southeast Asian Studies, Kyoto University, Kyoto,	Japan	2 (2.7)
Department of Veterinary Science, Faculty of Agriculture,	Japan	2 (2.7)
University of Miyazaki, Miyazaki,		
Graduate School of Medicine and Veterinary Medicine,	Japan	2 (2.7)
University of Miyazaki, Miyazaki,		
	Total	74

The leading first authors in LAMP Application research include Sugimoto, Chihiro (n = 10); Namangala, Boniface (n=9); Dorsey, Grant (n=9); Pillai, Dylan R (n = 8); Greenhouse, Bryan (N = 7); Fernández-soto, pedro (n= 6); Hayashida, Kyoko (n= 6); Arinaitwe, Emmanuel (n= 5); Fallahi, Shirzad (n= 5); Inoue, Noboru (n= 5); kajino, kiichi (n= 5); kamy, moses (n= 5); Muro, Antonio (n= 5); Suzuki, Yasuhiko (n = 5); Thekiso, Oriol M M (n= 5). Out of the 15 authors listed, 3 are based in Africa while the remaining 12 are affiliated with institutions in Japan, USA, Indonesia, United Kingdom,

Canada, Spain, Iran and England respectively (Table 3).

Although, Dorsey, Grant (from Joint University of California San Francisco, San Francisco) held the 2nd position for the most productive author based on principal author analysis (n = 9) and ranked as the 1st most collaborative author (n = 42), while Sugimoto, Chihiro secured the 2nd highest total link strength (n= 41). Likewise, Namangala, Boniface and Greenhouse, Bryan are the 3rd most collaborative author, total link strength (n= 37) (Table 4).

Table 3: Top 15 most productive Principal Authors (First author) in LAMP Applications Research in Worldwide Research

Author	H-Index	Country	Affiliation	Documents (%)
Sugimoto, Chihiro	58	Japan	Hokkaido University, Sapporo 001-0020, Hokkaido	10(10.6)
Namangala, Boniface	32	Zambia	School of Veterinary Medicine, University of Zambia	9(9.6)
Dorsey, Grant	77	USA	University of California San Francisco, San Francisco,	8(8.5)
Pillai, Dylan R	NA	Canada	University of Calgary Cumming School of Medicine, Calgary, Alberta	8(8.5)
Greenhouse, bryan	NA	USA	University of California San Francisco, San Francisco	7(7.4)
Fernández-soto, Pedro	NA	Spain	University of Salamanca,	6(6.4)
Hayashida, Kyoko	52	Japan	Hokkaido University, Sapporo	6(6.4)
Arinaitwe, Emmanuel	90	Uganda	Infectious Diseases Research Collaboration, Kampala,	5(5.3)
Fallahi, Shirzad	53	Iran	University of Medical Sciences, Khorramabad	5(5.3)
Inoue, Noboru	NA	England	Research Support, Non-U.S. Gov't	5(5.3)
Kajino, Kiichi	NA	Japan	Hokkaido University, Sapporo, Hokkaido	5(5.3)
Kamya, Moses	91	Uganda	Makerere University College of Health Sciences, Kampala	5(5.3)
Muro, Antonio	57	Spain	University of Salamanca, 37007	5(5.3)
Suzuki, Yasuhiko	53	Japan	Hokkaido University, Sapporo	5(5.3)
Thekiso, Oriol M M	31	South Africa	North-West University, Potchefstroom	5(5.3)
			Total	94

Table 4: The most Influential Authors through Co-Authorship Collaboration Networks

Author	Number of documents	Collaboration Networks	Affiliation
Sugimoto, Chihiro	10	41	Hokkaido University, Sapporo 001-0020, Hokkaido
Namangala, Boniface	9	37	School of Veterinary Medicine, University of Zambia
Dorsey, Grant	8	42	University of California San Francisco, San Francisco,
Pillai, Dylan R	8	7	University of Calgary Cumming School of Medicine, Calgary, Alberta
Greenhouse, bryan	7	37	University of California San Francisco, San Francisco
Fernández-soto, pedro	6	8	University of Salamanca,
Hayashida, kyoko	6	24	Hokkaido University, Sapporo
Arinaitwe, Emmanuel	5	35	Infectious Diseases Research Collaboration, Kampala,
Fallahi, Shirzad	5	1	University of Medical Sciences, Khorramabad
Inoue, Noboru	5	25	Research Support, Non-U.S. Gov't
Kajino, Kiichi	5	21	Hokkaido University, Sapporo, Hokkaido
Kamya, Moses	5	36	Makerere University College of Health Sciences, Kampala
Muro, Antonio	5	7	University of Salamanca, 37007
Suzuki, Yasuhiko	5	8	Hokkaido University, Sapporo
Thekiso, Oriol M M	5	14	North-West University, Potchefstroom

Analysis of publications from sources with the most output.

Table 5 shows the journals that have published the highest volume of research related to LAMP Applications research in the globe. The top sources include PLoS ONE, Journal Clinical Microbiology, Journal Virology Methods, Acta Tropica, PLOS Neglected Tropical Diseases, Scientific Reports, Malaria Journal, Japanese Journal of Infectious Diseases, Lancet Microbe,

Laboratory Chip, BMC Pediatrics, Analytica Chimica Acta, American Journal of Tropical Medicine and Hygiene. Of these Publications, nine journals have an impact factor (JCR 2024). Four of these publications such as; Journal Clinical Microbiology, Lancet Microbe, Laboratory Chip, Analytica Chimica Acta have an impact factor exceeding 5. Five of the journals are published in United State of America and United Kingdom respectively.

Table 5: Analysis of Journals with the highest number of publications in the globe

Article Source	No of Document	Impact factors	Country of origin	Abbreviation
PLOS One	51	2.9 (2023)	USA	PLOS One
Journal Clinical Microbiology	40	6.1 (2024)	USA	Journal of Clinical Microbiology
journal Virology Methods	28	2.2 (2023)	USA	Journal of Virology Methods
Acta Tropica	9	2.1 (2024)	Netherlands	Acta Tropical
PLOS Neglected Tropical Diseases	17	3.4(2023)	USA	PLoS Neglected Tropical Diseases
Scientific Reports	16	3.8 (2024)	United Kingdom	Science Report
Malaria Journal	15	2.4 (2023)	United Kingdom	Malaria Journal
Japanese Journal of Infectious Diseases	4	1.3 (2024)	Japan	Japan Journal of Infectious Diseases
Lancet Microbe	6	20.9 (2024)	United Kingdom	Lancet Microbe
Laboratory Chip	6	6.1(2024)	United Kingdom	Laboratory Chip
BMC Pediatrics	2	2.1 (2024)	United Kingdom	BMC Pediatrics
Analytica Chimica Acta	3	5.7 (2024)	Netherlands	Annals of Chemistry Acta
American Journal of Tropical Medicine and Hygiene	6	1.9 (2024)	USA	Americal Journal of Tropical Medicine and Hygiene

The collaborative network among institutions carrying out LAMP Applications research in the World. The mapping criterion was established at a minimum of 1 collaborative effort. Out of the 1334 institutions that met the criteria, only 1000 (%) were interconnected through collaborations. The institutions with the highest collaboration totals include the Infectious Diseases Research Collaboration, Kampala, Uganda (23 link strength), Makerere University College of Health Sciences, Kampala, Uganda (22 link strength), Department of Medical Microbiology, Radboud, University Medical Center, Nijegen, the

Netherlands (10 link strength), London School of Hygiene and Tropical Medicine, London, United Kingdom (9 link strength), Department of Medicine, University of California, San Francisco, USA (8 link strength), Department of Clinical Research, London School of Hygiene and Tropical Medicine, London, United Kingdom (6 link strength), Centers for disease control and prevention, Atlanta, Georgia, USA (5 link strength), Department of Infection Biology, London, United Kingdom (5 link strength), Department of Medicine (5 link strength), Institute for Health Metrics and evaluation ,

University of Washington, Seattle, USA (5 Link strength), Chicago Medical School, Rosalind Franklin University, North-Chicago, Illinois (4 link strength),

and Tropical Medicine, London, United Kingdom and the Joint clinical research centre, Kampala; Department of Clinical Research, London School of Hygiene and Tropical Medicine, London, United Kingdom; Institute for Health Metrics and evaluation, University of Washington, Seattle, USA and Makerere University College of Health Sciences, Kampala, Uganda respectively (Fig 3a and Fig 3b).

However, the strongest overall collaboration, with a link strength of 23, occurred among the Infectious Diseases Research Collaboration, Kampala, Uganda; London School of Hygiene

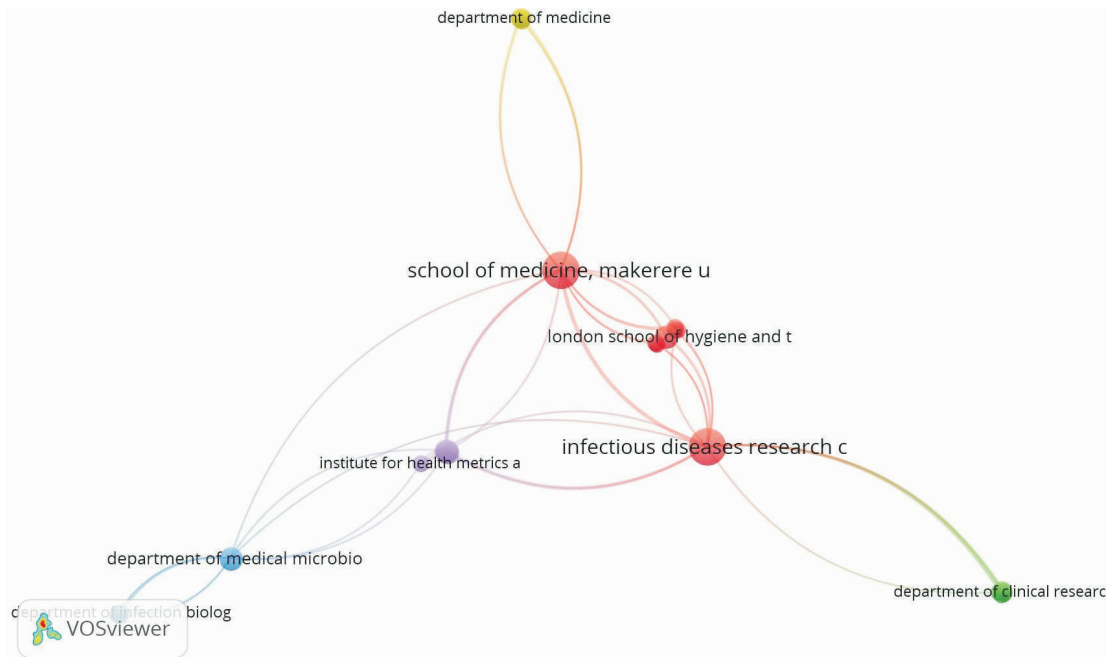


Figure 3a: Collaborative network among institutions publishing LAMP Applications Research

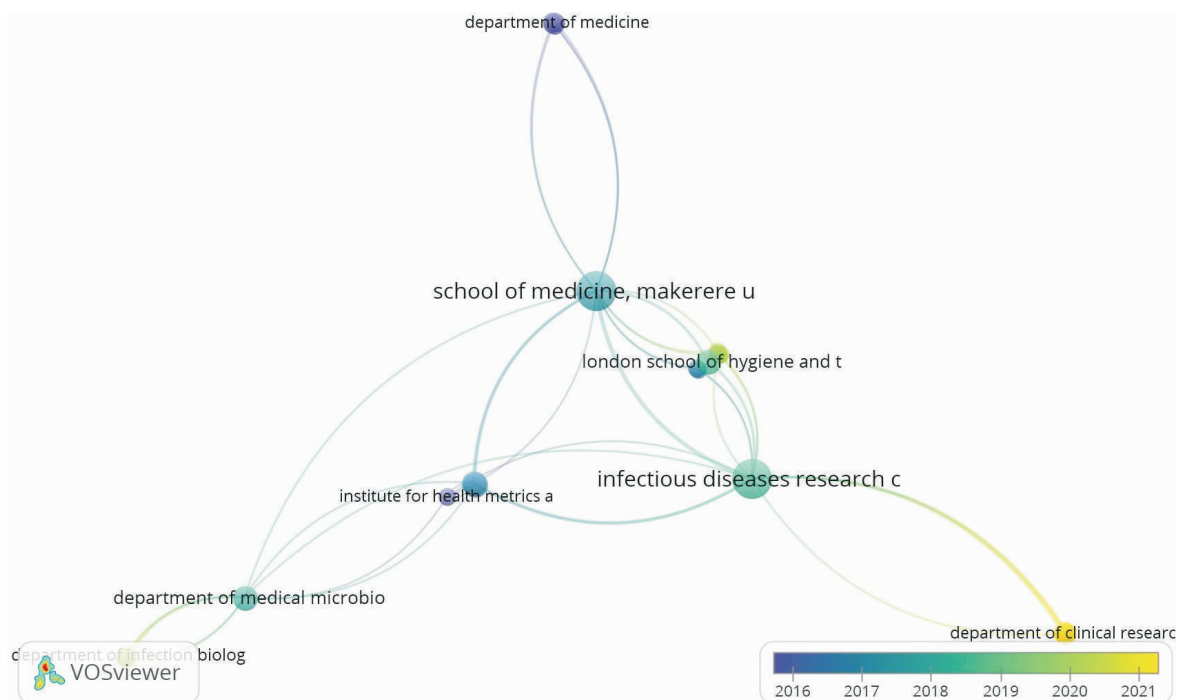


Figure 3b: Overlay visualization of collaborative network among institutions publishing LAMP Applications Research

Overall analysis of co-authorship among authors

The network and overlay visualization of co-authors comprised of individuals who have published at least three research articles related to LAMP Applications research. The network consists of 16 nodes, 53 co-authorship links, a total link strength of 120, and is divided into 3 clusters (Fig. 4a and 4b)

Each node symbolizes an author, with the size of the node indicating the author's activity or number of publications, while the connections between authors represent their collaborative relationships. Notably, 65 (2.5%) of the 2601 authors who met the threshold (at least 3 publications) were found to have no collaborative connections.

With respect to total link strength, Red cluster : Sugimoto, Chihiro (n= 110, Total link strength = 41), Namangala, Boniface (n= 9, Total link

strength = 37), Hayashida, Kyoko (n= 6, Total link strength = 24), Kajino Kiichi (n= 5, Total link strength= 21), Moonga Ladslav (n=3, Total link strength = 12) were the authors in the network of cluster 1 involving in LAMP Applications research in the globe.

In Green cluster, Yin, Hong (n= 4, Total link strength = 7); Luo, Jianxun (n= 3, Total link strength = 3), Igarashi, Ikuo (n= 3, Total link strength = 5); Karanis, Panagiotis (n= 4, Total link strength = 3); Thekiso, Oriel (n= 5, Total link strength = 14), were the authors in the network of cluster 2 involving in LAMP Applications research in the globe

In Blue cluster, Inoue, Noboru (n= 5, Total link strength = 25), Kawazu, Shin-ichiro (n= 3, Total link strength = 15); Nakao, Ryo (n= 3, Total link strength = 15), were the authors in the network of cluster 3 involving in LAMP Applications research in the globe (Fig. 4a and 4b).

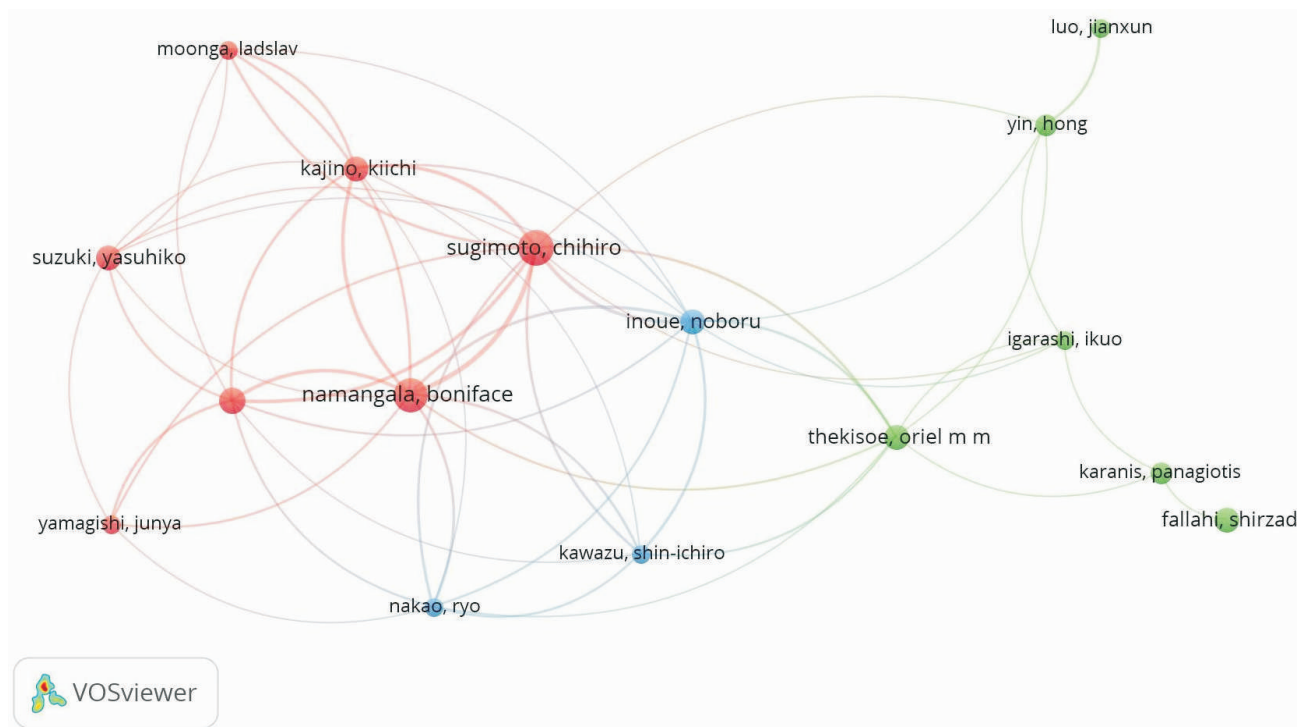


Figure 4a: Co-authorship network among authors publishing LAMP Application Research

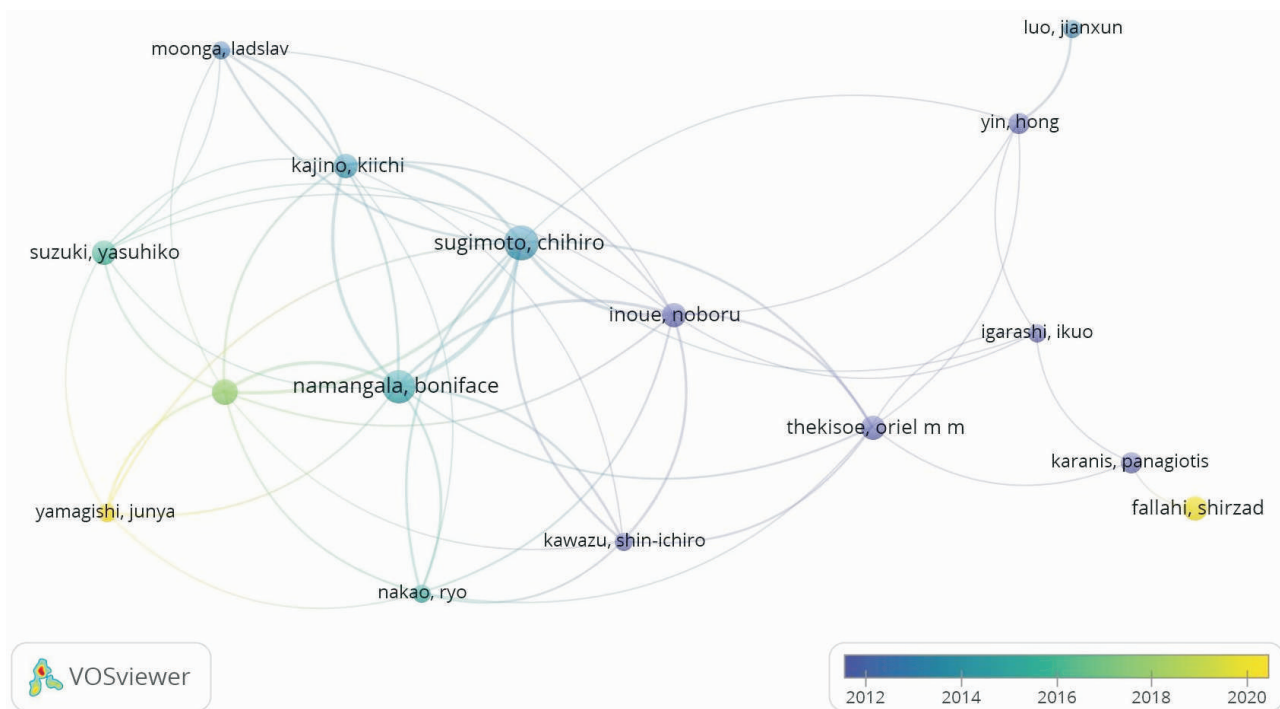


Figure 4b: Overlay visualization of Co-authorship among authors publishing articles per year related to LAMP Applications Research.

Analysis of keywords and hotspots

The hotspot analysis of author keywords used in LAMP Applications related research. The map contains keywords that represented more than 4 times. For this, precisely 109 keywords were eligible. The keywords were classified into 7 clusters by the network visualization. Nucleic Acid Amplification Techniques explored bacterial and fungal diseases (n= 277), in the cluster 1 (Red color). human (n=249), Antibacterial agent (n=10), betalactamase (n=9), *Escherichia coli* (n=6), Fungal DNA (n=6).

Molecular diagnostic technique for viral related diseases (n= 33), in the cluster 2. RNA Viral (n= 33) Point of Care Systems (n=17), Clinical Laboratory Techniques (n= 8), Viral pneumonia (n=5), Coronavirus (n=9), covid-19 testing (n=13), Sars-COV2 (n= 33)

Malarial related conditions with respect to age groups in the cluster 3 (Blue colour).

Plasmodium falciparum (n= 16); *Plasmodium vivax* (n= 7).

Cluster 4 (yellow) stood for food contamination and bacterial zoonotic diseases condition. Food contamination (n= 6); Food microbiology (n= 7); *Neisseria meningitidis* (n=6); point of care testing (n= 9); Swine diseases (n= 7)

Cluster 5 (purple) depicted keywords related to trematodes and helminth diseases condition. *Schistosoma mansoni* infection (n= 5); Helminth DNA (n= 7); African trypanosomiasis (n= 11); Faeces specimen (n= 20); *Cryptosporidium* (n= 5).

Assessment of leishmania DNA (n= 8); Loop mediated isothermal amplification (n= 9); HIV (N= 5) in the cluster 6 (Turquoise colour).

Sensitivity and specificity of Tuberculosis with sputum (n= 184); *Mycobacterium tuberculosis* (n= 18); Sputum (n= 11) in the cluster 7 (orange colour)

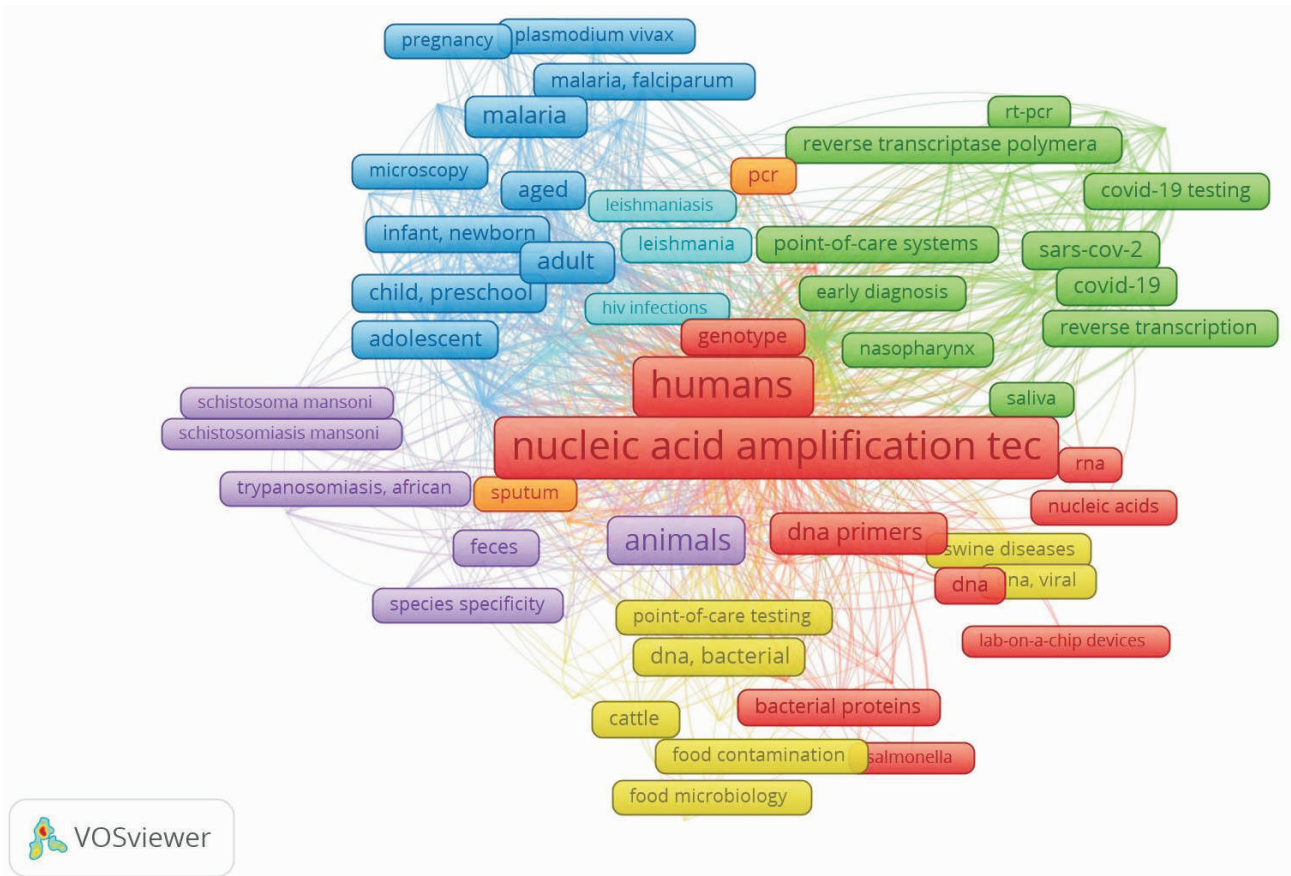


Figure 5a: Network visualization of Keyword hotspots

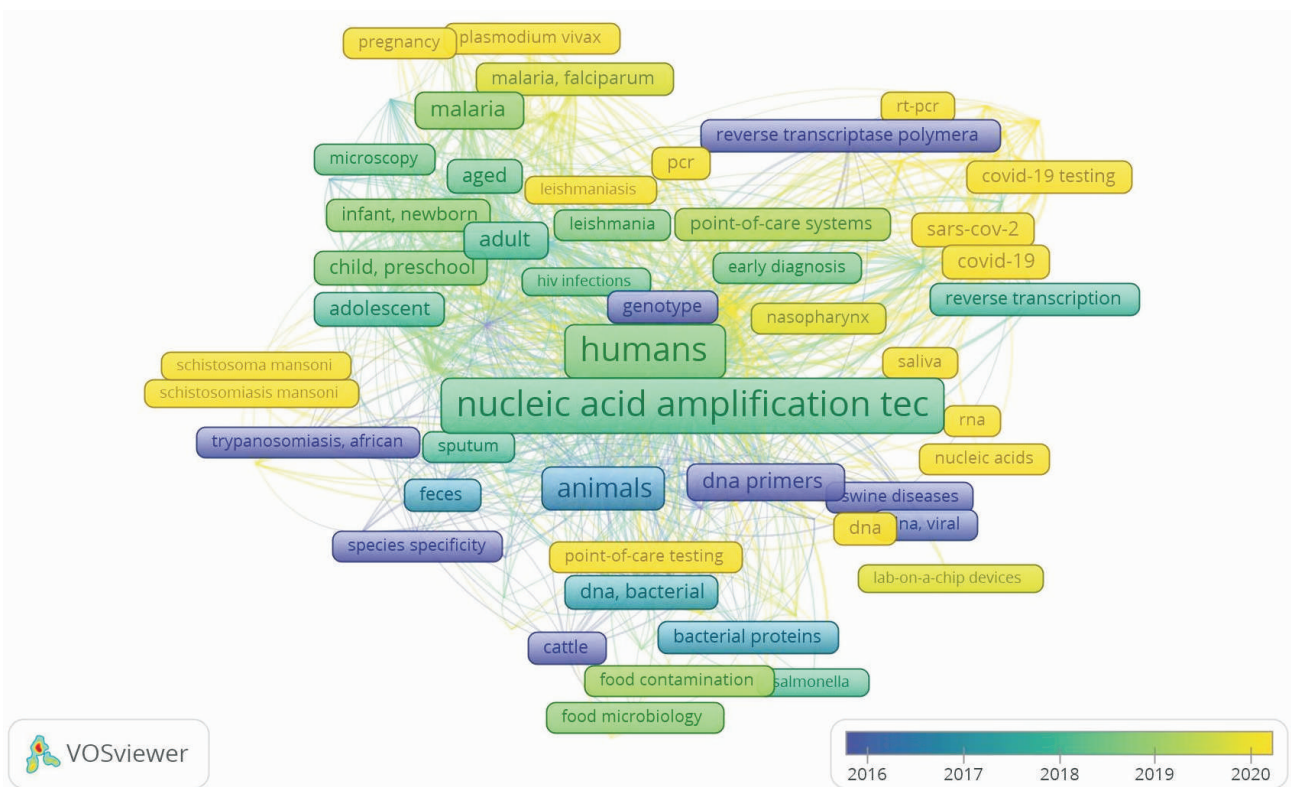


Figure 5b: Overlay visualization of Keyword hotspots

Discussion

The growth trend of LAMP applications publications shows Peak in 2022 followed by a sharp drop in 2023, suggesting a potential decline in research interest, funding, or applications. There is a slow rise in 2024, which indicates a possible recovery or renewed interest, potentially driven by new applications, including emerging uses or innovations in LAMP technology, improved methodologies, and increased awareness. The slow rise in 2024 might indicate that researchers are exploring new avenues or applications.

The lower prevalence rate of publication output on LAMP application research among poor resource countries can be attributed to insufficient financial resources can hinder research initiatives, equipment purchases, and personnel hiring. Skilled researchers might migrate to better-resourced countries, reducing local research capacity. Poor resource countries might have restricted access to scientific literature, databases, and collaborations. Some countries with lower publication outputs in the list, which might be considered poor resource countries, include: Ethiopia: 17 publications (1.9%), Tanzania: 6 publications (0.7%), Zambia: 9 publications (1.0%), and Cameroon: 11 publications (1.3%). These countries might face challenges securing research initiatives (Parida *et al.*, 2008). These challenges result in a significant disparity in research output between poor resource countries and high-income countries (Sauerborn *et al.*, 2000; Kapiriri and Martin, 2009; Amerson and Strang, 2015; Asah and Kaasbøll, 2023). According to recent studies, investing in research capacity building, infrastructure development, and international partnerships can help bridge this gap (Asah and Kaasbøll, 2023).

The prevalence rate of publications on LAMP Application based on countries indicated that Japan showed the highest productive outputs followed by United States of America and China. Only the top seven countries from the globe—Japan, United State of America, China, Iran, United Kingdom, India, Thailand—rank favorably on a global scale of 5% in terms of the number of publications concerning LAMP Application research, occupying the 1st, 2nd, 3rd, 4th, 5th, 6th and 7th positions, respectively. The prevalence rate of publications on Loop-mediated isothermal amplification (LAMP) applications is

higher among rich resource countries and lower among poor resource countries due to several factors. Firstly, rich countries have more resources to invest in research and development, enabling scientists to conduct studies and publish findings (Tomlinson *et al.*, 2011). Secondly, well-established research institutions, state-of-the-art laboratories, and access to advanced equipment and reagents facilitate high-quality research in rich countries (Njiru, 2012). Thirdly, rich countries often attract top talent and retain skilled researchers, contributing to more publications (Muñoz, 1996; Amerson and Strang, 2015; Asah and Kaasbøll, 2023). Fourthly, researchers in rich countries frequently collaborate with international partners, increasing opportunities for publication and knowledge sharing (Lau *et al.*, 2016; Costello and Zumla, 2000; Malekzadeh *et al.*, 2020).

Conclusion

Nucleic Acid Amplification Techniques explored bacterial and fungal diseases; viral related diseases; Malarial parasites; food contamination and bacterial zoonotic diseases and trematodes, and helminth diseases are the most hotspot analysis of author keywords in this study. The proportion of publications on LAMP applications is greater among rich resource countries and lesser among poor resource countries. The lower proportion of publication output on LAMP application research among poor resource countries can be contributed to insufficient financial resources that can hinder research initiatives, equipment purchases, and personnel hiring. Poor resource countries might have restricted access to scientific literature, databases, and collaborations

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