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A systematic review protocol for Biometrics in healthcare: strategies for improving safety and privacy of patients' records in sub-Saharan Countries

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We use this protocol and it's working

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Abstract

Background: The healthcare system is increasingly adopting biometric services to deliver safe, efficient, and cost-effective care. However, security concerns arise when users forget their passwords, share them, jot them down, or store them in close proximity to their computers. Further, some passwords are easily guessable, which allows unauthorized access to entire systems. The aim of this systematic review is to appraise evidence on biometric identification strategies for improving safety and privacy of patient's records in sub-Saharan African Countries

Methods: A systematic review will be conducted on studies that report on medical record security improvement techniques in African countries. Using relevant search terms, a systematic search for suitable peer-reviewed literature will be done in the following electronic bibliographic databases: PubMed, Theses Global and African Journals Online (AJOL), Cochrane Database of Systematic Reviews, and Google Scholar. An electronic search will be carried out for papers describing biometrics in healthcare: improved patient safety and privacy in African countries. The search strategy will encompass biometric terms such as fingerprint, facial, or iris recognition for authentication, along with keywords related to patient safety, Africa, healthcare, and patient privacy.

Discussion: This systematic review will provide a thorough assessment of the existing literature, evidence synthesis, identification of best practices, strategies for overcoming barriers and challenges, consideration of ethical and legal issues, cost-effectiveness assessment, identification of research gaps, and serving as educational resources. The findings will contribute to understanding how biometric play a significant role not only in ensuring the privacy and security of healthcare in sub-Saharan Africa. This review will provide guidance and support evidence-based decision-making in a region with specific healthcare opportunities and challenges by synthesizing current knowledge. A systematic review will direct future efforts and where resources should be allocated in the region by identifying areas that need more research. Overall, the findings of this systematic review.

Guidelines

Aim of the review

The aim of this systematic review is to appraise evidence on biometric identification strategies for improving safety and privacy of patient's records in sub-Saharan African Countries.

Before start

Study question

What are the strategies for implementing biometric technologies to improve the safety and privacy of patients' records in sub-Saharan African healthcare settings and the impact of these strategies on healthcare outcomes within the context of the sub-Saharan African healthcare system?

Methodology

- 1 The reviewers will conduct a systematic review of studies that report on strategies for implementing biometric technologies to improve the safety and privacy of patients' records in sub-Saharan African healthcare settings and what is the impact of these strategies on healthcare outcomes within the context of the sub-Saharan African healthcare system.
- 2 The review will be carried out in accordance with the Preferred Reporting items for Systematic Reviews Protocols (PRISMA-P) (Wells et al., 2000).
- 3 The PRISMA 2020 flow diagram for systematic reviews which includes searches of databases and registers will be adapted. This systematic review will follow pre-specified methods as stated in a protocol to be registered in PROSPERO.
- 4 The PCC (Population or Participants (P), Concept (C) and Context (C)) framework will guide in identifying the population of interest which are Sub-Saharan African.
Healthcare settings: Concept which is the impact of the strategies on healthcare outcomes: the Context which is sub-Saharan African healthcare system.

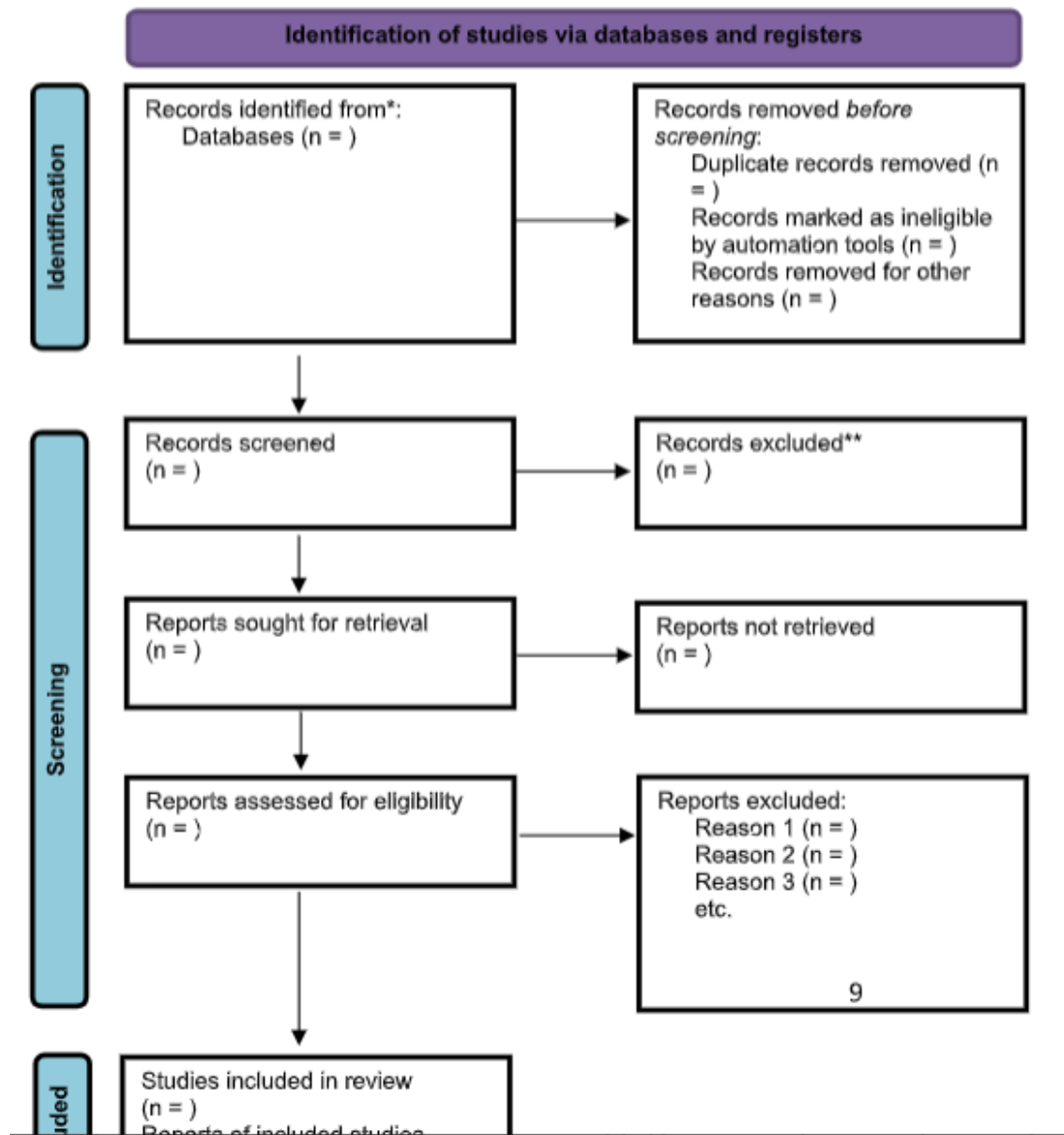


Figure 1. PRISMA 2020 flow diagram for new systematic reviews which includes searches of databases and registers

Search strategy

- 5 A systematic search will be conducted for eligible peer reviewed literature in the following electronic bibliographic databases, PubMed, Theses Global and African Journals online (AJOL), Cochrane Database of Systematic Reviews, Scopus and Google scholar using relevant search terms.
- 6 An electronic search will be conducted for studies describing biometrics strategies in healthcare to improve safety and privacy of patient's records in sub-Saharan African Countries.

- 7 Literature searches will be conducted using a combination of key concepts and Medical Subject Headings (MeSH) with their synonyms, using terms such as biometric (biometrics such as fingerprint, facial or iris recognition as a form of authentication), Patient Safety, Africa, healthcare and privacy for patients.
- 8 Reference lists of included studies will be screened for other potential and eligible studies which would have been missed in our searches.
- 9 The search strategy will be developed in consultation with a research librarian.
- 10 An initial search will be performed in PubMed using the following term combination with appropriate Boolean operators and truncations. Full search terms for the databases are provided as annex: (Biometrics OR "Healthcare" OR "Patient records") AND (Safety OR Privacy) AND "Sub-Saharan Africa" AND "Systematic review" The search strategy will be adapted for each database.
- 11 For each search conducted, we will document in detail the date of search, the search engine, and the number of publications retrieved.

Study selection-Inclusion and exclusion criteria

12

Note

The selection criteria and exclusion will guide in identifying relevant and eligible articles.

The search will be limited to English peer-reviewed publications reporting on biometric identification strategies for improving patient health medical records in sub-Saharan African countries.

- 13 Types of study designs will include randomized controlled trials (RCTs), interventional studies with qualitative, quantitative, and cohort or cross-sectional designs.
- 14 Only articles from 2003 to 2023 will be included, as most African countries have implemented national biometric digital identity systems in the past two decades (Digital identification in Africa: Frameworks and initiatives, 2021).
- 15 Studies that evaluated biometric programs that cover user-centric, rights- respecting, privacy-respecting, or responsiveness to types of biometrics, policymakers, biometric strategy with regard to identification, surveillance, diagnosis, treatment, follow-up of hospital visitation, patient registration, affecting e-Health, service users, or service providers will be included.

- 16 Excluded are non-English papers, observational studies; reviews; abstracts; conference papers and study protocols.

Study selection-Study selection and quality assessment

- 17 Two reviewers from a team of five will independently assess titles and abstracts of studies identified by search, using Rayyan screening tool.
- 18 The other three reviewers will screen the full texts of identified peer-reviewed articles to evaluate potential eligibility.
- 19 Another reviewer's opinion will be sought in case of persisting disagreements until consensus will be reached.
- 20 The study selection will be guided by the PRISMA guidelines, and quality of these studies will be assessed using the critical appraisal skills program (CASP 2015) to ensure methodically proven reliable evidence-based studies in the review.
- 21 The following quality criteria will be used:
1. Whether the research questions or objectives were clearly stated?
 2. Whether the approach was appropriate for the research question?
 3. Whether the study context was clearly described?
 4. Whether the role of the researcher was clearly described?
 5. Whether the sampling method was clearly described?
 6. Whether the sampling strategy was appropriate for the research question?
 7. Whether the method of data collection was clearly described?
 8. Whether the data collection method was appropriate to the research question?
 9. Whether the method of analysis was clearly described?
 10. Whether the analysis was appropriate for the research question?
 11. Whether the claims made are supported by sufficient evidence?
- 22 All studies included in the review will concentrate on Biometrics in healthcare to improve safety and privacy of patient records in sub-Saharan Africa healthcare setting, with clearly stated objectives addressing the review question.

Dealing with missing data

- 23 Attempts to contact the authors concerned will be made when important data is missing from the included studies. Missing data will be considered as the absence of any results adding weight to the study and insufficient reporting on study outcomes.

Assessment of reporting biases

- 24 Reporting bias will be investigated in every included study depending on the type of study. Each will be assessed by two reviewers for reporting bias. These review authors will discuss any questions or uncertainties that arise during the process.
- 25 A third reviewer will be available for any disagreements not resolved.
- 26 The studies excluded from the review analysis will not further be assessed at this stage.
- 27 The PRISMA guidelines will be used to guide study selection, and the quality of these studies will be assessed using Cochrane Collaboration's Risk of Bias 2 (RoB 2) tool to ensure methodically proven reliable evidence-based studies are included in the review.
- 28 The RoB 2 tool will be used to assess the risk of bias in the included RCTs. RoB 2 will be used to assess bias in the following domains: bias arising from the randomization process, bias resulting from deviations from intended interventions, bias resulting from missing outcome data, bias in outcome measurement, bias in the selection of the reported result, and bias in the selection of the reported result. assess publication bias, then synthesize, interpret, and draw conclusions based on the assessment of bias and the synthesis of results, draw conclusions about the efficacy and safety of biometrics-based strategies for improving patient record safety and privacy in Sub-Saharan African countries.

Data extraction and synthesis

- 29 To assess information on key study aspects such as objectives, designs, samples, performance measurement tools, and results, data will be extracted into a data extraction form created in Microsoft Excel.
- 30 The data extraction form will also include a description of the intervention and outcome measures (Table 1).
- 31 The data to be extracted includes author(s) names, date of publication, country of publication study title, journal full reference, aims or research question, participant characteristics, sampling method, study design, data collection, data analysis and most relevant findings conclusions and comments.
- 32 Data will be extracted by two independent authors who are AMH and OK who will be responsible for identifying relevant literature and extracting data. Where there will be disagreement, CJ, LH JMZ who are third parties will be consulted. Data from the selected articles will be analyzed using NVivo version 12 software.

Data Analysis

- 33
- The analysis will involve identification, coding, and exploration of relationships of themes within data.
- 34
- A code list will be developed which will comprise of broad themes collectively agreed upon by the research team members after preliminary reading of abstracts.
- 35
- The code list will later be modified to accommodate emergent themes and will be imported into NVivo 12.
- 36
- Data from the included articles will be coded in the respective nodes by two separate researchers including the principal investigator AMH and OK to allow for inter-coder reliability tests. Where they will be discrepancies, the researchers will discuss until consensus will be reached on how information will be coded.
- 37
- Code reports will identify specific factors affecting biometrics strategies to improve safety and privacy of patient records in sub-Saharan African healthcare settings.
- 38
- For any articles where this is unclear, the article will be carried forward into the full-text review.
- 39
- The full text of the remaining papers will be sourced, and independently evaluated to determine if all inclusion and exclusion criteria are met.
- 40
- A descriptive analysis of the contents of all papers reviewed will be conducted per category (thematic coding) and new (sub) categories deriving from the literature will be added to the framework (Table 2).

Table 2: Summary of included systematic reviews

	A	B	C	D	E	F	G	H	I	J
	Auth ors	Ye ar	Cou ntry	Study title	Study Po pulation	Sampl e Size	Strate gies	Outco me	Main Findi ngs	Comments/Ass ociated factors

Strategy for data synthesis



- 41 The data from the results of each included study will be extracted into defined data extraction spreadsheets.
- 42 The results will be synthesized in a narrative manner.
- 43 Based on the included manuscripts in the final library, the plausibility of a meta-analysis will be assessed depending on the variation of the included data presented.

Protocol references

REFERENCES

1. Adegbenle, A., Rotimi, U. N. O. & James, A. O. A. 2020. Ethics In Biometrics Authentication. GSJ, 8.
2. Ahmed, I., Sullivan, K. & Priye, A. 2022. Multi-resin masked stereolithography (MSLA) 3D printing for rapid and inexpensive prototyping of microfluidic chips with integrated functional components. Biosensors, 12, 652.
3. Allhoff, F. & Henschke, A. 2018. The internet of things: Foundational ethical issues. Internet of Things, 1, 55-66.
4. ALSAADI, I. M. 2015. Physiological biometric authentication systems, advantages, disadvantages and future development: A review. International Journal of Scientific & Technology Research, 4, 285-289.
5. Alsaadi, I. M. 2021. Study on most popular behavioral biometrics, advantages, disadvantages and recent applications: A review. Int. J. Sci. Technol. Res, 10.
6. Anne, N., Dunbar, M. D., Abuna, F., Simpson, P., Macharia, P., Betz, B., Cherutich, P., Bukusi, D. & Carey, F. 2020. Feasibility and acceptability of an iris biometric system for unique patient identification in routine HIV services in Kenya. International journal of medical informatics, 133, 104006.
7. Aramendía, J. M. High Grade of Authentication.
8. Aurigemma, S., Mattson, T. & Leonard, L. 2017. So much promise, so little use: What is stopping home end-users from using password manager applications?
9. Ball, M. J., Hannah, K. J., Cortes-Comerer, N. & Douglas, J. V. 2023. The health informatics series: Evolving with a new discipline. International Journal of Medical Informatics, 105008.
10. Basil, N. N., Ambe, S., Ekhatior, C., Fonkem, E., Nduma, B. N. & Ekhatior, C. 2022. Health Records Database and Inherent Security Concerns: A Review of the Literature. Cureus, 14.
11. Bhagavatula, R., Ur, B., Iacovino, K., Kywe, S. M., Cranor, L. F. & Savvides, M. 2015. Biometric authentication on iphone and android: Usability, perceptions, and influences on adoption.
12. Bhattacharyya, D., Ranjan, R., Alisherov, F. & Choi, M. 2009. Biometric authentication: A review. International Journal of u-and e-Service, Science and Technology, 2, 13-28.
13. Brown, C. L. 2012. Health-Care Data Protection and Biometric Authentication Policies: Comparative Culture and Technology Acceptance in China and in the United States. Review of Policy Research, 29, 141-159.
14. Campbell, J. C. 1999. A comparative analysis of mainframe and network computer security: From 1975 to present. Quinnipiac University.
15. Carter, J. H. 2001. Electronic medical records: a guide for clinicians and administrators, ACP Press.
16. Chowhan, R. S. & Tanwar, R. 2019. Password-less authentication: methods for user verification and identification to login securely over remote sites. Machine Learning and Cognitive Science Applications in Cyber Security. IGI global.
17. Chuma, K. G. & Ngoepe, M. 2022. Security of electronic personal health information in a public hospital in South Africa. Information Security Journal: A Global Perspective, 31, 179-195.
18. Dantcheva, A., Elia, P. & Ross, A. 2015. What else does your biometric data reveal? A survey on soft biometrics. IEEE Transactions on Information Forensics and Security, 11, 441-467.
19. Dauner, K. N. & Loomer, L. 2021. A qualitative assessment of barriers and facilitators associated with addressing social determinants of health among members of a health collaborative in the rural Midwest. BMC Health Services Research, 21, 1-12.

20. Doucek, P., Pavlíček, L., Sedláček, J. & Nedomová, L. 2020. Adaptation of password strength estimators to a non-English environment—the Czech experience. *Computers & security*, 95, 101757.
21. Effah, J., Owusu-Oware, E. & Boateng, R. 2020. Biometric identification for socioeconomic development in Ghana. *Information Systems Management*, 37, 136-149.
22. El-Sayed, A. 2015. Multi-biometric systems: a state of the art survey and research directions. *IJACSA) International Journal of Advanced Computer Science and Applications*, 6.
23. Fernández-Alemán, J. L., Señor, I. C., Lozoya, P. Á. O. & Toval, A. 2013. Security and privacy in electronic health records: A systematic literature review. *Journal of Biomedical Informatics*, 46, 541-562.
24. Filkins, B. L., Kim, J. Y., Roberts, B., Armstrong, W., Miller, M. A., Hultner, M. L., Castillo, A. P., Ducom, J. C., Topol, E. J. & Steinhubl, S. R. 2016. Privacy and security in the era of digital health: what should translational researchers know and do about it? *Am J Transl Res*, 8, 1560-80.
25. Fye, W. B. 1994. A history of the origin, evolution, and impact of electrocardiography. *The American journal of cardiology*, 73, 937-949.
26. Garg, M. & Goel, A. 2022. A systematic literature review on online assessment security: Current challenges and integrity strategies. *Computers & Security*, 113, 102544.
27. Hagener, M. 2015. Beautiful Data/The Democratic Surround. *NECSUS. European Journal of Media Studies*, 4, 223-227.
28. Jin, G. Z. 2018. Artificial intelligence and consumer privacy. *The Economics of Artificial Intelligence: An Agenda*. University of Chicago Press.
29. Johnson, A. E., Bulgarelli, L., Shen, L., Gayles, A., Shammout, A., Horng, S., Pollard, T. J., Hao, S., Moody, B. & Gow, B. 2023. MIMIC-IV, a freely accessible electronic health record dataset. *Scientific data*, 10, 1.
30. Kassab, M. K. I., Naser, S. S. A. & Al Shobaki, M. J. 2017. An analytical study of the reality of electronic documents and electronic archiving in the management of electronic documents in the Palestinian pension agency (PPA).
31. Kogetsu, A., Ogishima, S. & Kato, K. 2018. Authentication of patients and participants in health information exchange and consent for medical research: a key step for privacy protection, respect for autonomy, and trustworthiness. *Frontiers in genetics*, 9, 167.
32. Kreindler, S. A. 2017. The three paradoxes of patient flow: an explanatory case study. *BMC Health Services Research*, 17, 1-14.
33. Kumar, D., Maurya, A. K. & Baranwal, G. 2021. IoT services in healthcare industry with fog/edge and cloud computing. *IoT-based data analytics for the healthcare industry*. Elsevier.
34. Maeko, M. E. & Van Der Haar, D. Technical Requirements Survey on Multimodal Biometric Selection for Deployment in Governments. *International Congress on Information and Communication Technology*, 2023. Springer, 1057-1073.
35. Marohn, D. 2006. Biometrics in healthcare. *Biometric Technology Today*, 14, 9-11.
36. Merdenyan, B. & Petrie, H. 2022. Two studies of the perceptions of risk, benefits and likelihood of undertaking password management behaviours. *Behaviour & Information Technology*, 41, 2514-2527.
37. Mogli, G. 2012. Role of Biometrics in healthcare privacy and security management system. *Sri Lanka Journal of Bio-Medical Informatics*, 2.
38. Moolla, Y., De Kock, A., Mabuza-Hocquet, G., Ntshangase, C. S., Nelufule, N. & Khanyile, P. 2021. Biometric recognition of infants using fingerprint, iris, and ear biometrics. *IEEE Access*, 9, 38269-38286.
39. Nelson, G. S. Practical implications of sharing data: a primer on data privacy, anonymization, and de-identification. *SAS global forum proceedings*, 2015. 1-23.
40. NG, A. C. K. 2018. Contemporary Identity and Access Management Architectures: Emerging Research and Opportunities: Emerging Research and Opportunities.

41. Nigam, D., Patel, S. N., Raj Vincent, P., Srinivasan, K. & Arunmozhi, S. 2022. Biometric authentication for intelligent and privacy-preserving healthcare systems. *Journal of Healthcare Engineering*, 2022.
42. North-Samardzic, A. 2020. Biometric technology and ethics: Beyond security applications. *Journal of Business Ethics*, 167, 433-450.
43. Oosthuizen, W. T. 2017. Reconciling patient safety and liability: lessons from a just culture. University of Pretoria.
44. Paul, M., Maglaras, L., Ferrag, M. A. & Almomani, I. 2023. Digitization of healthcare sector: A study on privacy and security concerns. *ICT Express*.
45. Politou, E., Alepis, E. & Patsakis, C. 2018. Forgetting personal data and revoking consent under the GDPR: Challenges and proposed solutions. *Journal of cybersecurity*, 4, ty001.
46. Razzak, M. I., Imran, M. & Xu, G. 2020. Big data analytics for preventive medicine. *Neural Computing and Applications*, 32, 4417-4451.
47. Reese, K., Smith, T., Dutson, J., Armknecht, J., Cameron, J. & Seamons, K. A usability study of five {two-factor} authentication methods. *Fifteenth Symposium on Usable Privacy and Security (SOUPS 2019)*, 2019. 357-370.
48. Rodrigues, P. & Santos, H. Health users' perception of biometric authentication technologies. *Proceedings of the 26th IEEE international symposium on computer-based medical systems*, 2013. IEEE, 320-325.
49. Ruthven, I. & Chowdhury, G. G. 2015. *Cultural heritage information: Access and management*, Facet publishing.
50. Sibbald, S. L., Wathen, C. N. & Kothari, A. 2016. An empirically based model for knowledge management in health care organizations. *Health care management review*, 41, 64-74.
51. Singh, G., Bhardwaj, G., Singh, S. V. & Garg, V. 2021a. Biometric Identification System: Security and Privacy Concern. In: AWASTHI, S., TRAVIESO- González, C. M., Sanyal, G. & Kumar Singh, D. (eds.) *Artificial Intelligence for a Sustainable Industry 4.0*. Cham: Springer International Publishing.
52. Singh, G., Bhardwaj, G., Singh, S. V. & Garg, V. 2021b. Biometric identification system: security and privacy concern. *Artificial intelligence for a sustainable industry 4.0*, 245-264.
53. Singh, H. & Sittig, D. F. 2016. Measuring and improving patient safety through health information technology: The Health IT Safety Framework. *BMJ Quality & Safety*, 25, 226-232.
54. Solano, J., Camacho, L., Correa, A., Deiro, C., Vargas, J. & Ochoa, M. Risk-based static authentication in web applications with behavioral biometrics and session context analytics. *Applied Cryptography and Network Security Workshops: ACNS 2019 Satellite Workshops, SiMLA, Cloud S&P, AIBlock, and AIoT*, Bogota, Colombia, June 5–7, 2019, *Proceedings 17*, 2019. Springer, 3-23.
55. Sousa, M. J., Pesqueira, A. M., Lemos, C., Sousa, M. & Rocha, Á. 2019. Decision-making based on big data analytics for people management in healthcare organizations. *Journal of medical systems*, 43, 1-10.
56. Sula, C. A. 2015. Digital humanities and digital cultural heritage (alt-history and future directions). *Cultural Heritage Information: Access and Management*. London: Facet, 13-36.
57. Sutrop, M. Ethical issues in governing biometric technologies. *Ethics and Policy of Biometrics: Third International Conference on Ethics and Policy of Biometrics and International Data Sharing, ICEB 2010, Hong Kong, January 4-5, 2010. Revised Papers*, 2010. Springer, 102-114.
58. Thiel, A. 2020. Biometric identification technologies and the Ghanaian 'data revolution'. *The Journal of Modern African Studies*, 58, 115-136.
59. Wang, L. & Alexander, C. A. 2013. Medical applications and healthcare based on cloud computing. *International Journal of Cloud Computing and Services Science*, 2, 217.
60. Wells, G. A., Shea, B., O'connell, D., Peterson, J., Welch, V., Losos, M. & Tugwell, P. 2000. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Oxford.



61. Zhu, H., Jin, W., Xiao, M., Murali, S. & Li, M. 2020. Blinkey: A two-factor user authentication method for virtual reality devices. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, 4, 1-29.