International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Evaluating the Role of Deep Learning in Early Cancer Detection: Enhancing Diagnostic

Lapologang Motladiile

Abstract

Deep learning (DL) is increasingly recognized as a transformative tool in medical diagnostics, particularly in early cancer detection. Its capacity to extract complex patterns from largescale imaging datasets has enabled the development of automated screening systems with promising accuracy and speed. This systematic review critically evaluates the diagnostic performance, efficiency, and safety of DL models, while also addressing ethical, regulatory, and implementation challenges. Following PRISMA guidelines, peer-reviewed literature from 2015 to 2025 was screened across major databases. A total of 42 studies met the inclusion criteria and were analysed using a combination of meta-analysis and narrative synthesis.

The findings reveal that convolutional neural networks (CNNs) routinely achieved high diagnostic metrics, with several models reporting accuracies above 95% for cancer image classification tasks (Ahsan et al., 2023). In comparative studies, DL models performed on par with or exceeded expert radiologists in terms of sensitivity and specificity—particularly in mammography, where AI demonstrated an average sensitivity of 0.85 compared to radiologists' 0.77 (Rodriguez-Ruiz et al., 2019). Additionally, DL models offer substantial reductions in image processing time, enabling near real-time diagnostic workflows (Shen et al., 2019). Despite these advances, generalizability remains a concern due to dataset bias, image heterogeneity, and overfitting risks (Zhou et al., 2021).

To address transparency issues, explainable AI (XAI) methods such as LIME and SHAP have been adopted to improve clinician trust and model interpretability (Gunning et al., 2019).

Ethical concerns surrounding data privacy, algorithmic fairness, and liability persist, especially under regulatory frameworks like GDPR and HIPAA (McCradden et al., 2020). While select DL systems have secured FDA clearance, widespread clinical adoption requires standardized validation, interpretability mandates, and cross-centre trial data.

In conclusion, DL holds significant promise in early cancer detection, offering enhanced diagnostic precision and operational efficiency. However, successful clinical integration depends on addressing ethical concerns, standardizing evaluation protocols, and ensuring robust external validation to safeguard patient outcomes.

References

1. Ahsan, M.M., Mahmud, M., Sahrain, S., Luna, S.A. and Siddique, Z., 2023. Deep learningbased models for early cancer detection using medical imaging: A systematic review. *Journal of Healthcare Engineering*, 2023, pp.1–19. https://doi.org/10.1155/2023/8040982
2. Gunning, D., Stefik, M., Choi, J., Miller, T., Stumpf, S. and Yang, G.Z., 2019. XAI—Explainable artificial intelligence. *Science Robotics*, 4(37), p.eaay7120.
3. https://doi.org/10.1126/scirobotics.aay7120

4. McCradden, M.D., Joshi, S. and Anderson, J.A., 2020. Ethical concerns around use of AI in health care: a focus on bias and interpretability. *BMJ Health & Care Informatics*, 27(3), e100097. https://doi.org/10.1136/bmjhci-2020-100097
5. Rodriguez-Ruiz, A., Krupinski, E., Mordang, J.J., Schilling, K., Heywang-Köbrunner, S.H., Sechopoulos, I. and Mann, R.M., 2019. Detection of breast cancer with mammography: effect of an artificial intelligence support system. *Radiology*, 290(2), pp.305–314. https://doi.org/10.1148/radiol.2018181371
6. Shen, D., Wu, G. and Suk, H.I., 2019. Deep learning in medical image analysis. *Annual Review of Biomedical Engineering*, 19, pp.221–248. https://doi.org/10.1146/annurev-bioeng-071516-044442
7. Zhou, L.Q., Wang, J.Y., Yu, S.Y., Wu, G.G., Wei, Q., Deng, Y.B., Liu, F., Zheng, J. and Cui, X.W., 2021. Artificial intelligence in medical imaging of the liver. *World Journal of Gastroenterology*, 27(7), pp.644–666. https://doi.org/10.3748/wjg.v27