Dorado, Abram C. **CMSC 199**

Deconstructing a Meta Analysis

1. Give the bibliographic entry for your selected meta-analysis.

Islam, M. M., Yang, H. C., Poly, T. N., Jian, W. S., & Li, Y. C. J. (2020). Deep learning algorithms for detection of diabetic retinopathy in retinal fundus photographs: A systematic review and meta-analysis. Computer Methods and Programs in Biomedicine, 191, 105320. https://doi.org/10.1016/j.cmpb.2020.105320

2. Give a 2-3 sentence summary of the article.

This meta-analysis evaluates the performance of deep learning (DL) algorithms in detecting diabetic retinopathy (DR) from retinal fundus photographs. After reviewing 23 studies, the meta-analysis revealed that DL algorithms showed high sensitivity and specificity for identifying referable DR, with a pooled area under the curve (AUROC) of 0.97. The findings suggest that DL-based automated tools could significantly enhance early detection, reducing the incidence of vision loss and improving workflow in clinical settings.

3. Break down the meta-analysis

**** What was the goal of the meta-analysis? What were its research questions or hypotheses?***

Goal of the Meta-Analysis:

- The meta-analysis aimed to evaluate the diagnostic performance of deep learning algorithms in detecting diabetic retinopathy (DR) using retinal fundus images. The primary objective was to measure how well DL methods could identify referable DR, focusing on sensitivity, specificity, and overall diagnostic accuracy.

Research Questions/Hypotheses:

- How effective are deep learning algorithms in detecting diabetic retinopathy from retinal fundus images?
- Do these algorithms demonstrate high diagnostic accuracy (sensitivity and specificity) for detecting referable DR?

**** Which databases did the authors consult? What range of dates?***

The authors consulted EMBASE, PubMed, Google Scholar, Scopus, and Web of Science. The search covered studies published between January 1, 2000, and March 31, 2019.

**** What search terms did the authors use?***

Search terms included “Retinopathy,” “Diabetic Retinopathy,” “Referable diabetic retinopathy,” “Retinal fundus image,” “Vision-threatening diabetic retinopathy,” “Deep learning,” “Convolutional neural network,” “Artificial intelligence.”

**** What were the authors' inclusion and exclusion criteria?***

Inclusion:

- Studies published in English, peer-reviewed.
- Studies utilizing DL algorithms for DR detection with specified evaluation metrics (accuracy, AUROC, sensitivity, specificity).
- Clear definitions of DR and the DL process.

Exclusion:

- Non-peer-reviewed publications, editorials, or short reports.
- Studies on traditional methods for DR detection that did not utilize DL-based approaches.

**** What were the characteristics that the authors examined in each article?***

Study design, Deep learning models used (CNN, DCNN, hybrid models), Datasets employed (number of images, source of images, and grade of DR), Diagnostic evaluation metrics (AUROC, sensitivity, specificity), Participant demographics, Performance of DL models for detecting referable DR

**** What were the main findings?***

The meta-analysis reported that deep learning algorithms achieved excellent diagnostic performance, with a pooled AUROC of 0.97 (95% CI: 0.95–0.98), sensitivity of 0.83 (95% CI: 0.83–0.83), and specificity of 0.92 (95% CI: 0.92–0.92). The results confirmed that DL models are highly effective for detecting referable DR from retinal fundus photographs, offering substantial benefits for automating DR screening and improving early detection.

**** What are the limitations of the meta-analysis?***

- Heterogeneity among studies: The included studies varied significantly in design, datasets, and diagnostic evaluation, making it challenging to standardize findings.
- Unclear generalization to real-world clinical settings: It is difficult to assess how well the algorithms would perform in practical, real-world DR screening programs.
- Image quality dependency: The performance of DL algorithms is heavily reliant on the quality and resolution of the images, potentially limiting their applicability in settings with lower-quality images.

**** What opportunities for further study were revealed by the meta-analysis?***

Future research should focus on validating the real-world applicability of these algorithms in diverse clinical environments, especially in regions with limited access to specialized ophthalmologists. Additionally, exploring methods to enhance the generalizability and interpretability of these models could foster greater trust in their clinical use. The meta-analysis also highlighted the need for further studies addressing the "black-box" nature of DL models to improve clinician acceptance.