

INTRODUCTION

- As authors, we have dedicated our efforts to exploring the evolving role of precision population medicine (PPM) in cancer care through comprehensive reviews. Cervical cancer (CC) is one disease site that we have meticulously studied.
- Our study underscores the immense potential benefits of artificial intelligence (AI) and radiomics (R) in propelling the PPM application to CC, a development that could revolutionize cancer care.
- The goals of PPM are to provide tailored, cost-effective care to individuals and develop cost-effective CC screening for resource-scarce populations. These are not just goals but urgent necessities in our fight against cancer.



Hull R, Mbele M, Makhaola T, et al. Cervical cancer in low and middle-income countries. *Oncol Lett.* 2020;20(3):2058-2074. doi:10.3892/ol.2020.11754

- The utilization of AI in CC has the potential to decrease health disparities for resource-scarce regions and populations, particularly for a malignancy with many risk factors, as seen in this figure from Hull et al.¹. Overwhelmingly, CC occurs due to human papillomavirus (HPV) infection.

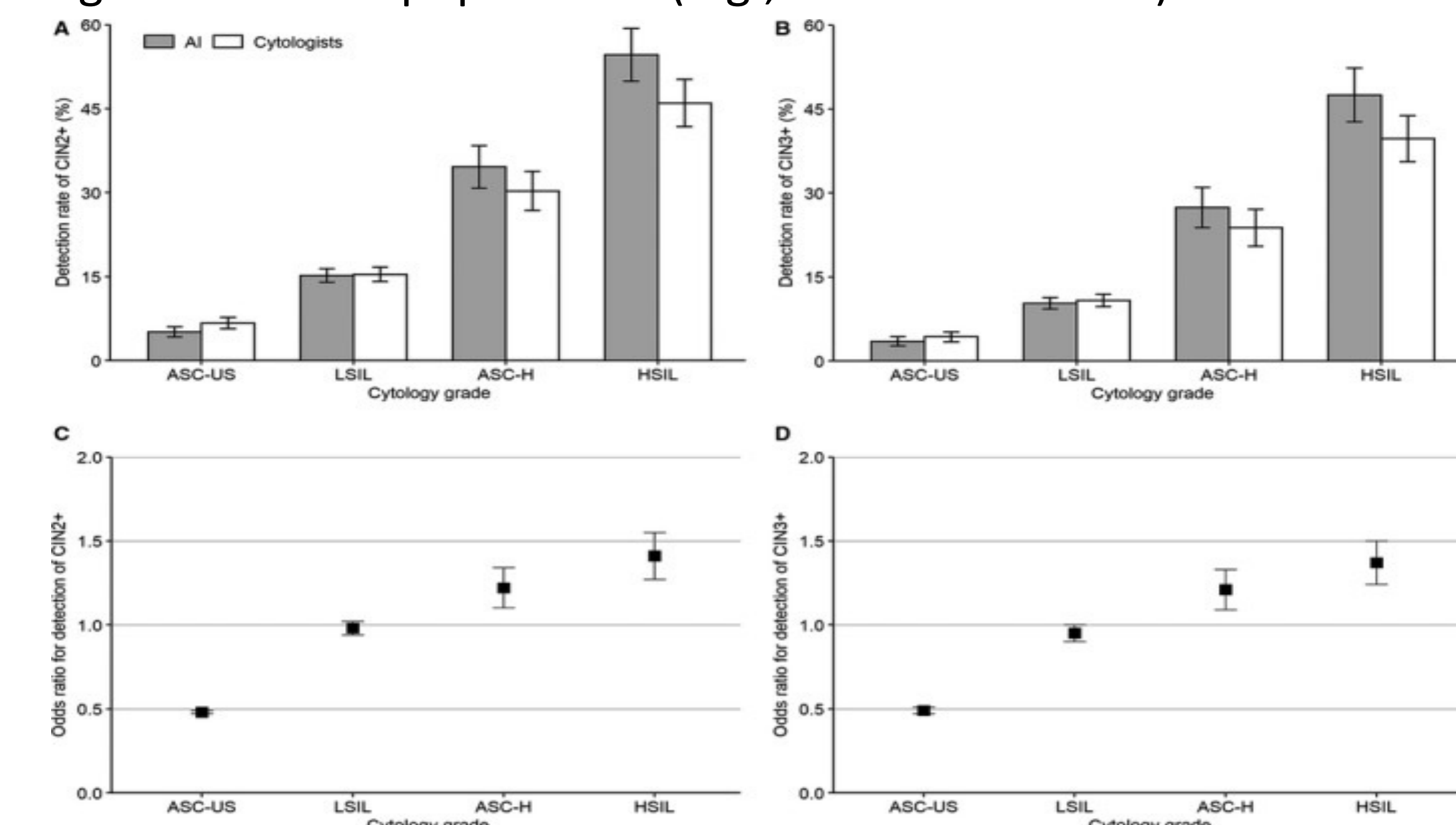
METHODS

- A comprehensive literature search was completed for studies from 2013 to 2023 using the PubMed, MEDLINE, and Google Scholar databases.
- Combinations of the following keywords were used: “artificial intelligence,” “machine learning,” “radiomics,” “precision medicine,” and “cervical cancer.”
- Commentaries, letters to the editor, and unpublished works were excluded.

RESULTS

CC Histology Analysis through AI

AI-automated Pap smear histological image analysis² is a potential PPM technique. Innovative approaches can increase access to CC screening among underserved populations (e.g., mailed HPV tests)³.

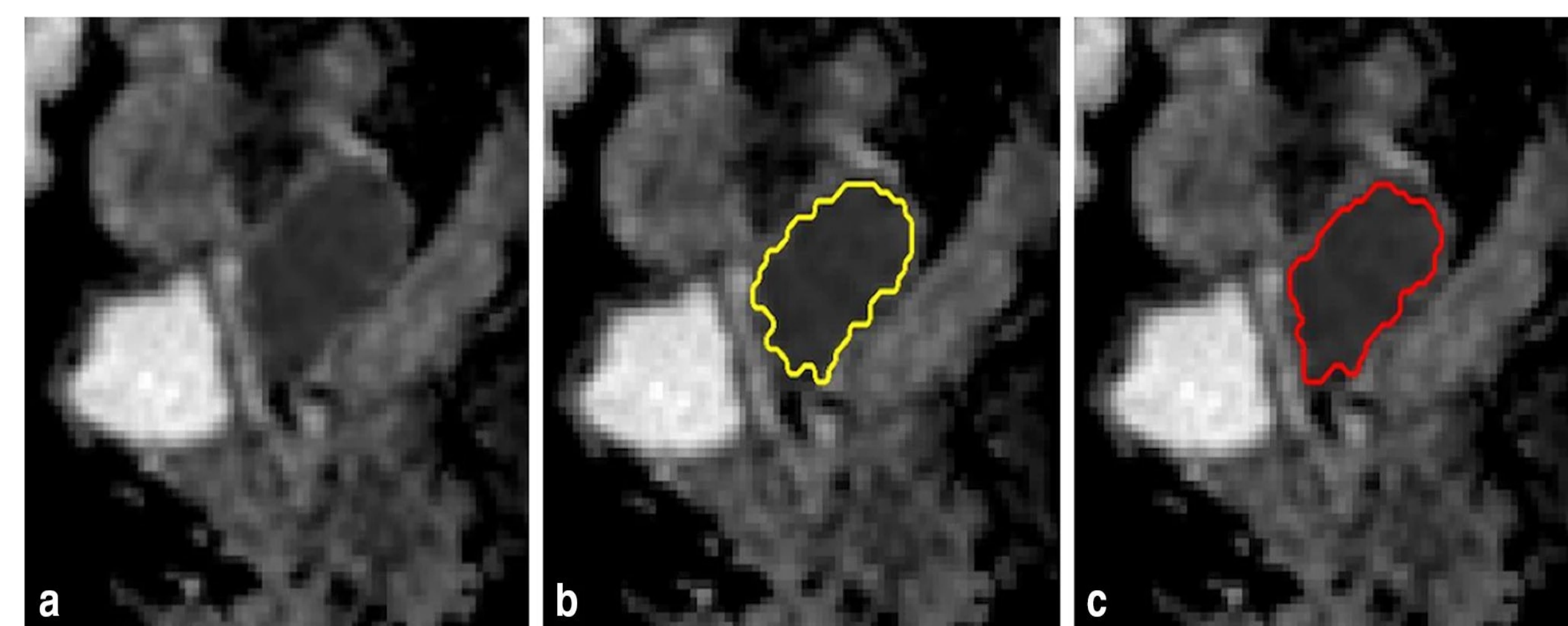


Bao H, Sun X, Zhang Y, et al. The artificial intelligence-assisted cytology diagnostic system in large-scale cervical cancer screening: A population-based cohort study of 0.7 million women. *Cancer Med.* 2020;9(18):6896-6906. doi:10.1002/cam4.3296

“Detection of CIN2+ (Fig A) and CIN3+ (Fig B) in cytology grades between AI-assisted and manual cytology, with respective odds ratios (Fig C, D) of AI relative to manual cytology”.

Deep Learning Tumor Localization

Importantly, R has demonstrated solid results for detecting CC with the potential for treatment response monitoring⁵. This may effectively supplement individualized healthcare for CC and aid in predicting population-specific genetics and characteristics of CC.

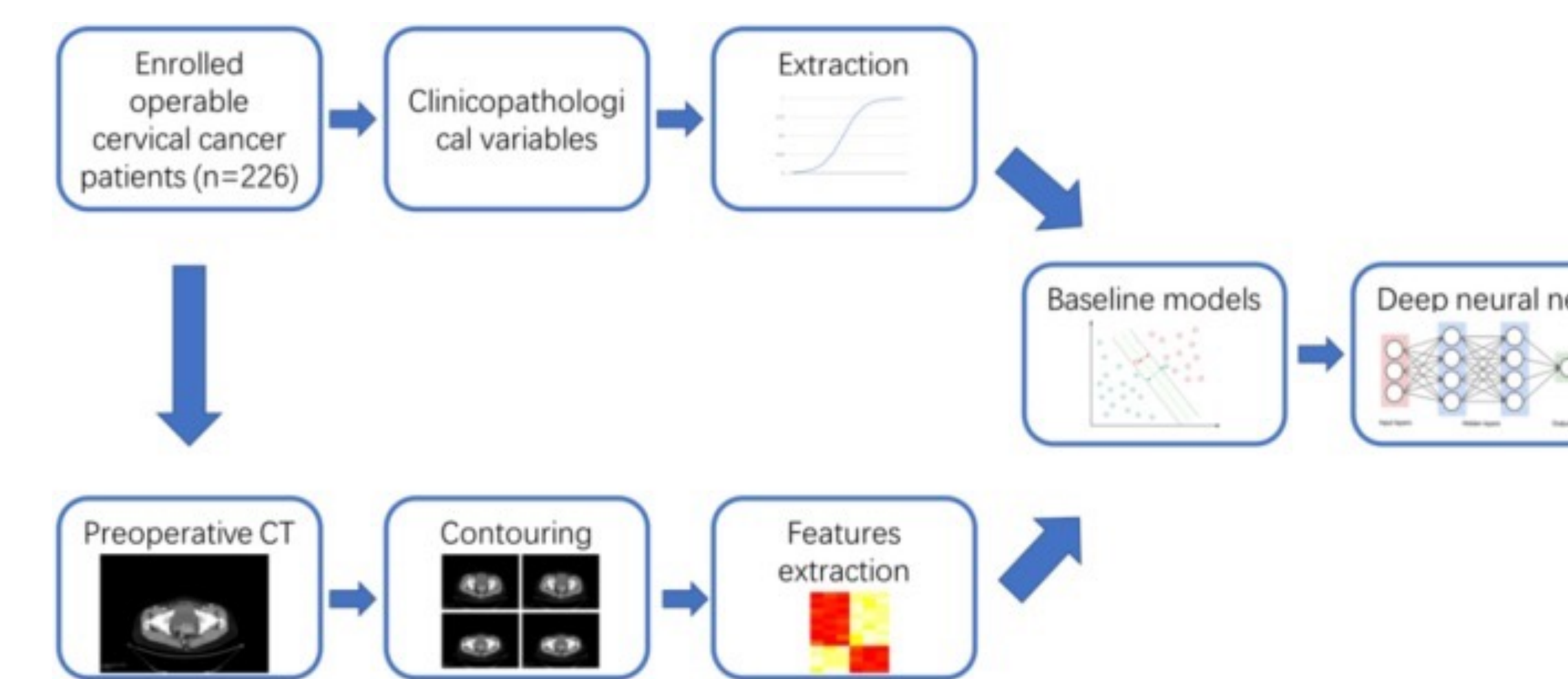


Lin YC, Lin CH, Lu HY, et al. Deep learning for fully automated tumor segmentation and extraction of magnetic resonance radiomics features in cervical cancer. *Eur Radiol.* 2020;30(3):1297-1305. doi:10.1007/s00330-019-06467-3

From Lin et al., an example of a localized, segmented cervical tumor. Manual labeling (yellow) versus predicted labeling (red) by the trained triple-channel input model showed a high Dice similarity coefficient, a calculation of tumor segmentation accuracy⁵.

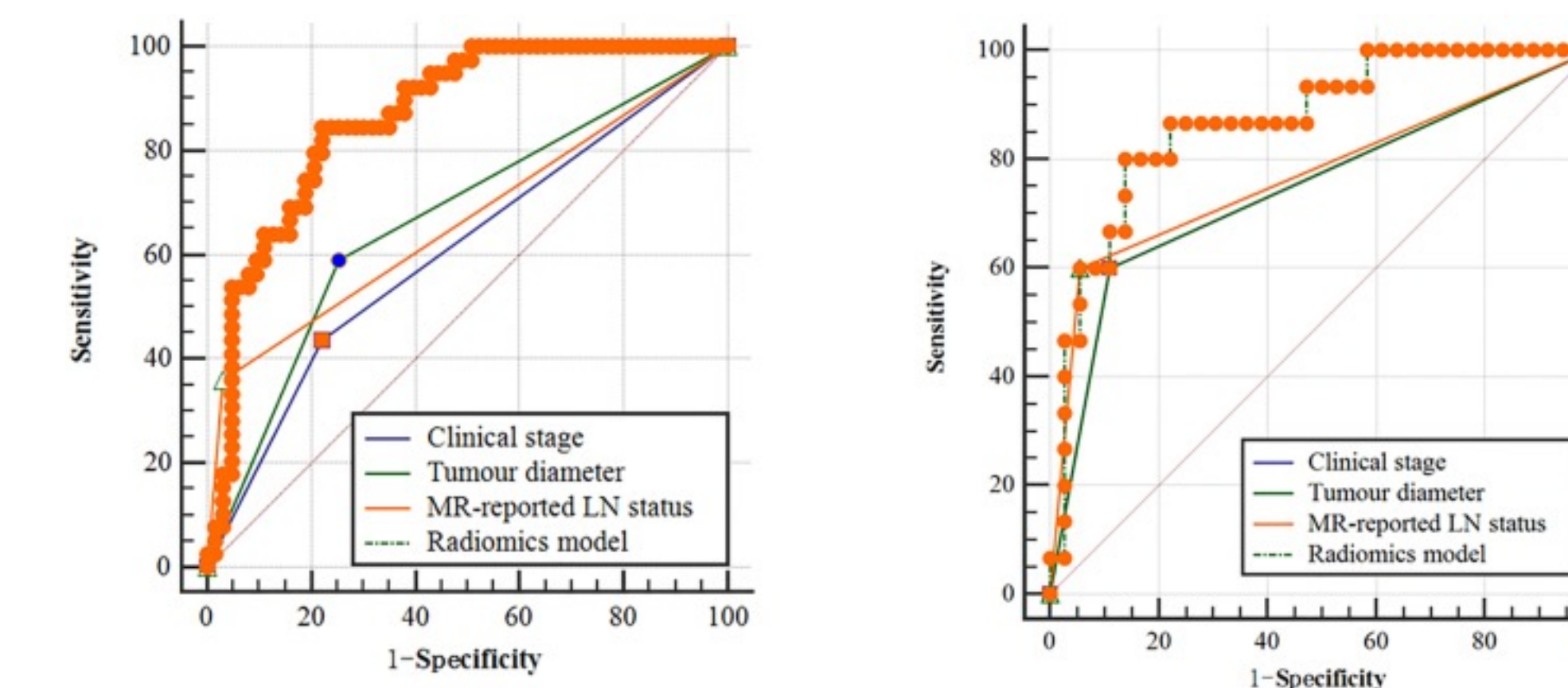
AI in Lymph Node Status and Predictive Value for CC

- In 2018, lymph node status was included in The International Federation of Gynecology and Obstetrics staging for CC.
- Machine learning (ML) with CT scans and clinical findings have created preoperative prediction models for lymph node metastasis (LNM) in early-stage CC, with an 89% accuracy and 92% specificity⁶.



Dong T, Yang C, Cui B, et al. Development and Validation of a Deep Learning Radiomics Model Predicting Lymph Node Status in Operable Cervical Cancer. *Front Oncol.* 2020;10:464. Published 2020 Apr 15. doi:10.3389/fonc.2020.00464

- An example of the input to a deep neural network pipeline used by Dong et al. in predicting lymph node status⁷.
- As a non-invasive prediction tool, R with preoperative MRI may better differentiate metastatic nodal involvement compared to other clinical or radiological techniques⁸. The figure from Yu et al. below demonstrates that the R model had better predictive value than the clinical stage, as seen by the area under the curve.



Yu YY, Zhang R, Dong RT, et al. Feasibility of an ADC-based radiomics model for predicting pelvic lymph node metastases in patients with stage IB-IIA cervical squamous cell carcinoma. *Br J Radiol.* 2019;92(1097):20180986. doi:10.1259/bjr.20180986

R segmentation of cervical tumors through diffusion-weighted imaging (DWI) and T2-weighted imaging (T2WI) has become an accurate and reliable tool compared to manual segmentation for preoperative prediction of LNM⁹. This could guide the decision for surgery for individuals in resource-scarce populations or tumors exhibiting population-specific characteristics.

CONCLUSION

- Noninvasive AI techniques, such as CT, MR DWI, and T2WI, have improved CC detection and diagnosis capability, which may be used in preoperative tumor segmentation and LNM identification in early-stage CC.
- ML and R may increase individualized patient treatment, which can be further employed in CC populations with specific, unique variables or where medical resources are limited^{10,11}.
- Many of these AI techniques can be employed promptly and population-wide, particularly for HPV and CC screening. This could increase individualized CC management in the same areas as one facet of PPM.

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