A Mobile-Accessible Cost-Effective AI-Aided Self-Assessment Tool for Early Measles Detection in Low-Resource Settings

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Introduction

- Measles is a very **contagious** disease, especially dangerous for young children. To stop its spread, it's important to catch it early. However, traditional tests for measles can be slow and expensive, especially in countries with **fewer resources**.
- Our project developed an easy-to-use, **AI-powered tool** that helps people quickly check if they might have measles. The tool uses a **deep learning model** to analyze skin rashes and combines it with **questions about symptoms and recent exposures**. This makes it easier to identify measles early and take necessary precautions, especially in areas **where medical resources are limited**.

Methods

Measles

Non-measles

Image selection

- **554** measles and **41741** non-measles skin lesion images included
  - Measles images from Publications (n=183); Encyclopedia articles (n= 72);News articles (n=133);Social media (n=64); 5 datasets (n=102)
  - Annotated by **age group, gender, skin tone, body region, and rash color**.

Deep learning

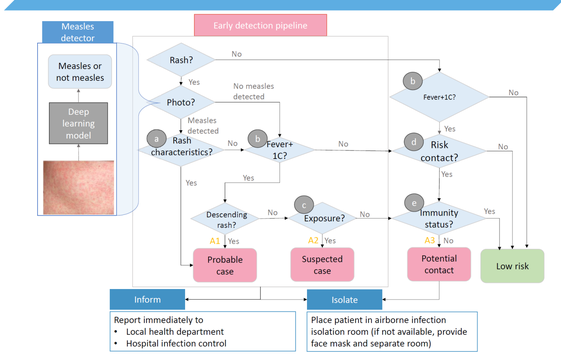
Training: Validation: Testing=8:1:1

Reduce class imbalance by **TenCrop** and **focal loss**

Data augmentation: random zoom out, resized crop, rotation, flip, etc.

Transfer learning with MobileNetV3

Self-assessment tool



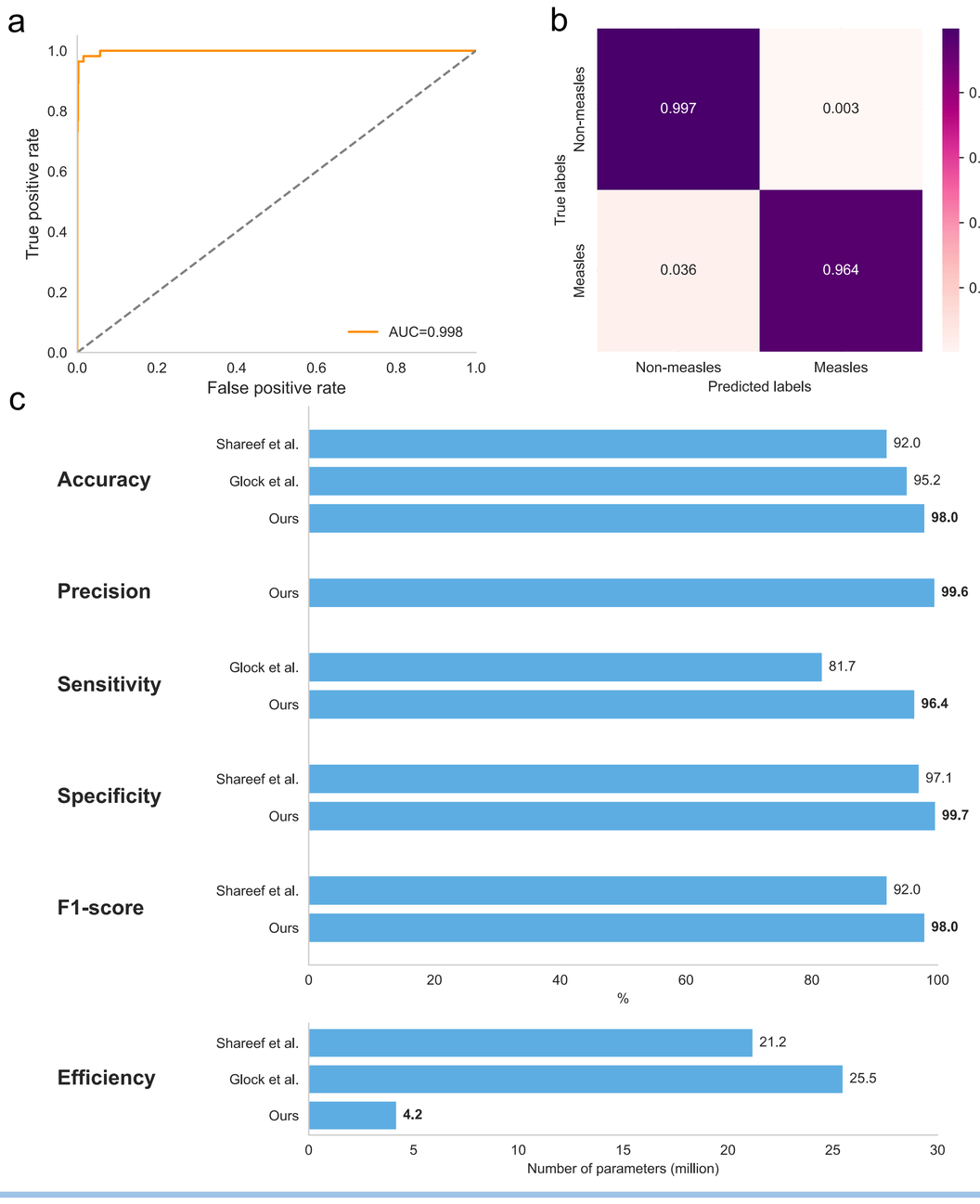
Risk level

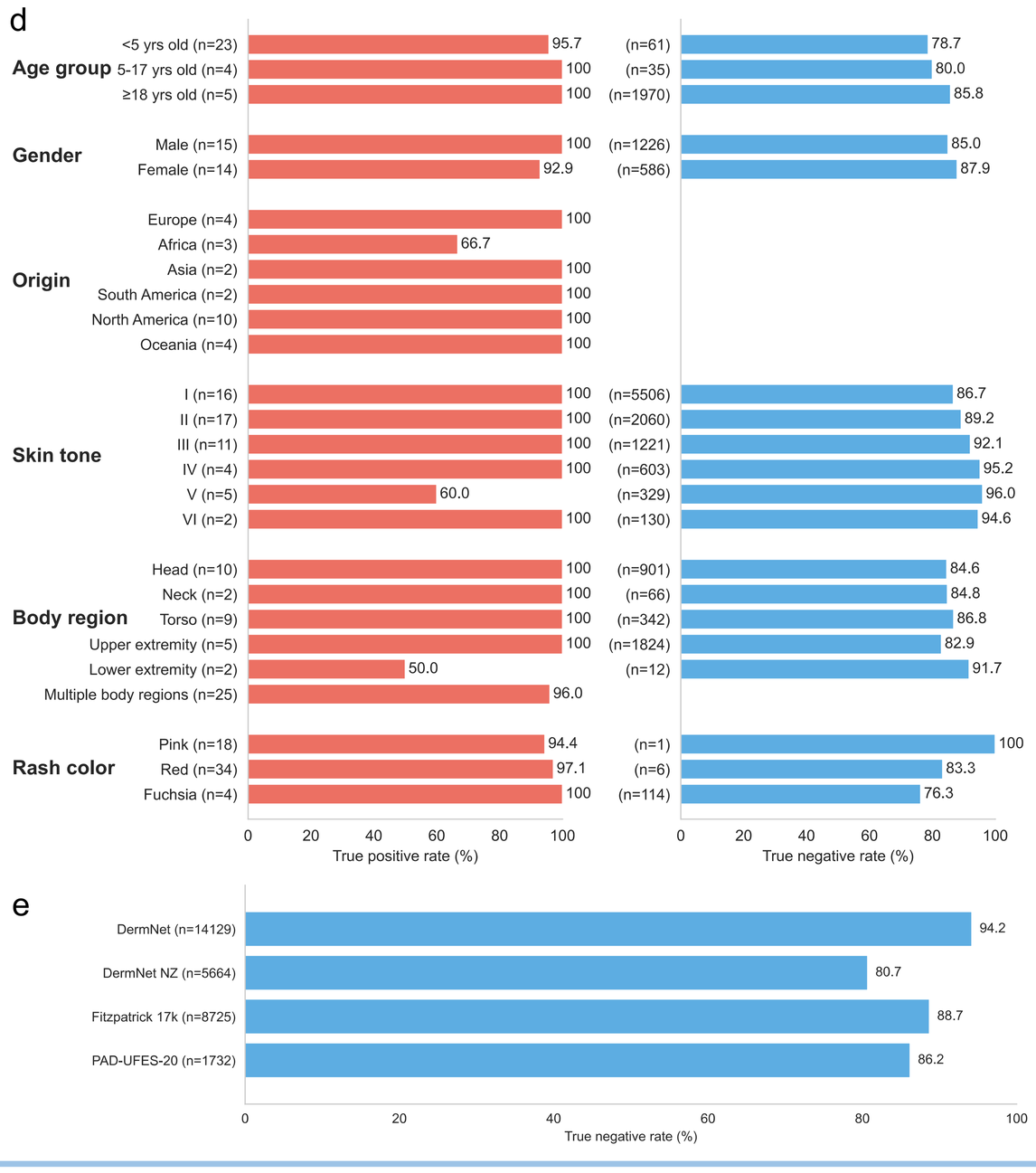
Risk score

(XGBoost algorithm)

Suggestions

Results





Conclusion

Scan the code to have a quick assessment

- **Model Accuracy**: high accuracy (**98.0%**), with strong **generalizability** across various image characteristics and external datasets.
- **Areas for Improvement**: Lower true positive rate was noted in younger children, females, and certain **skin tones**.
- **External Validation**: TNR varied significantly across different **skin conditions** in external validation.
- **Potential Utility**: serves as a valuable tool for early measles detection, particularly in resource-limited settings.
- **Ongoing Refinement**: Ongoing refinement is necessary to ensure robust performance across diverse populations and conditions.

References

1. World Health Organization. Measles: WHO; 2024 [accessed 24 February 2024]. Available from: https://www.who.int/news-room/fact-sheets/detail/measles.
2. Center for Disease Control and Prevention. Increase in Global and Domestic Measles Cases and Outbreaks: Ensure Children in the United States and Those Traveling Internationally 6 Months and Older are Current on MMR Vaccination: CDC; 2024 [accessed Apr 2, 2024]. Available from: https://emergency.cdc.gov/han/2024/han00504.asp.
3. World Health Organization. Global measles threat continues to grow as another year passes with millions of children unvaccinated: WHO; 2024 [accessed Apr 2, 2024]. Available from: https://www.who.int/news/item/16-11-2023-global-measles-threat-continues-to-grow-as-another-year-passes-with-millions-of-children-unvaccinated.
4. Centers of Disease Control and Prevention. Global Measles Outbreaks: CDC; 2024 [accessed June 11 2024]. Available from: https://www.cdc.gov/global-measles-vaccination/data-research/global-measles-outbreaks/?CDC_AAref_Val=https://www.cdc.gov/globalhealth/measles/data/global-measles-outbreaks.html.
5. Mulders MN. Global measles and rubella laboratory network support for elimination goals, 2010–2015. MMWR Morbidity and mortality weekly report. 2016;65.
6. Gyebi R, Okyere GA, Nakua EK, Aseidu-Bekoe F, Nti JSA, Ansah EO, et al. Prediction of measles patients using machine learning classifiers: a comparative study. Bulletin of the National Research Centre. 2023;47(1):115.
7. Brown DW, Warrener L, Scobie HM, Donadel M, Waku-Kouomou D, Mulders MN, et al. Rapid diagnostic tests to address challenges for global measles surveillance. Current opinion in virology. 2020;41:77-84.
8. Li C. Recognizing Measles: Key Symptoms and Features: Clearvue Health; 2024 [accessed Apr 2, 2024]. Available from: https://www.clearvuehealth.com/measlessymptoms/.
9. Shareef MM, Sunitha G, Prasad Sanaboina S, Sireesha M, Reddy Madhavi K, Antharam G, et al., editors. Measles Detection Using Deep Learning. International Conference on Computer & Communication Technologies; 2023: Springer.
10. Glock K, Napier C, Gary T, Gupta V, Gigante J, Schaffner W, et al., editors. Measles rash identification using transfer learning and deep convolutional neural networks. 2021 IEEE International Conference on Big Data (Big Data); 2021: IEEE.