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Artificial Intelligence-Based Anemia Detection Using Palm Image: A Systematic Review

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 22 November 2025 and was last updated on 22 November 2025.

INTRODUCTION

Review question / Objective This systematic review aims to identify and synthesize scientific evidence related to the effectiveness of non-invasive procedures that utilize AI for the detection of anemia through the analysis of palm images.

Rationale A number of prior systematic reviews have addressed the use of AI to detect anemia in a non-invasive manner (Asare, Appiahene, & Donkoh, 2023; Dimauro et al., 2020). However, a comprehensive review focusing on the use of AI using palm image has not yet been conducted. To address this, a systematic review was conducted that focused on the use of AI to detect anemia using palm images.

Condition being studied Anemia is a global health problem that affects various populations. It is estimated that approximately 40% of children aged 6-59 months, 37% of pregnant women, and 30% of women aged 15-49 years are affected by anemia. Anemia is caused by malnutrition, chronic disease, infection, heavy menstruation, family history, and pregnancy (WHO, 2025). In pregnant women, it has several impacts, such as increasing the risk of postpartum hemorrhage, premature rupture of membranes, premature birth, low birth weight, cesarean section, gestational hypertension, and neonatal asphyxia (Wang et al., 2025). In the case of adolescents, anemia can result in a diminished immune system, making them susceptible to disease and reducing their activity levels. In children, anemia has been shown to potentially impair cognitive function, learning abilities, and academic performance (Suprapti et al., 2025). Therefore, early detection is necessary for the timely management of anemia. Laboratory tests using venous blood samples to measure hemoglobin levels are the gold standard for

diagnosing anemia (Pasricha et al., 2024). However, this method is invasive and faces several challenges (Kesarwani et al., 2023), such as discomfort due to repeated blood sampling and the high costs associated with laboratory tests (Dimauro et al., 2023). Furthermore, this method is not feasible in field surveys or clinics with limited resources (Pasricha et al., 2024). Physical examination is often used to assess anemia (Lin et al., 2024). It is an important component of nursing practice, as it enables nurses to assess patients conditions through the examination and observation of signs and symptoms indicative of anemia (Maniago et al., 2021). Anemia is often accompanied by manifestation of pallor in areas of the body with less substantial dermal thickness (Bailey et al., 2025) that are not greatly affected by pigmentation (Lin et al., 2024), such as the palms of the hands. Nurses may examine these areas in patients with anemia to identify health changes (Bailey et al., 2025). However, this examination is subjective and depends on the examiner's experience (Lin et al., 2024). A rapid, inexpensive, and readily available non-invasive device is needed to address these limitations. One potential approach invloves the utilization of an artificial intelligence-based strategy.

The health sector stands to benefit from AI in the form of image-based automatic diagnosis. This innovative solution overcomes inaccuracy and the lack of human interpretation experience (Ghaffar Nia et al., 2023), providing advantages in terms of convenience. The utilization of AI in healthcare settings has been demonstrated to improve diagnostic precision, expedite the identification of suitable treatment modalities, and streamline clinical laboratory testing. This integration curtails expenses, minimize human error and conserve time (Alowais et al., 2023).

METHODS

Search strategy A literature search was conducted on three electronic databases: ScienceDirect, PubMed, and ProQuest. Keywords used in the article search were ("Anemia" OR "Hemoglobin Deficiency") AND ("Artificial Intelligence" OR "Machine Learning" OR "Deep Learning") AND ("Palm" OR "Palmar" OR "Palm Image"). The article search process used the Boolean operators "AND" and "OR."

Participant or population Children, adults, pregnant women, elderly (anemic and non-anemic).

Intervention Artificial Intelligence-based anemia detection using palm image.

Comparator Other AI models or type, hemoglobin test.

Study designs to be included Observational and interventional studies, articles that developed or evaluated artificial intelligence to detect anemia using palm images and reported the performance metrics of AI model were included in this systematic review.

Eligibility criteria The articles included in the present study were: (1) original articles published between 2020 and 2025; (2) articles discussing the use of AI for anemia detection using palm images; and (3) open-access studies in English. The articles excluded in this study were: (1) review articles, study protocols, abstracts or conference proceedings, case study articles, and opinions; (2) articles sourced from books, encyclopedias, and conferences; (3) articles of which the full text was not available; (4) articles not focused on AI-based anemia detection using palm images.

Information sources A literature search was conducted on three electronic databases: ScienceDirect, PubMed, and ProQuest.

Main outcome(s) Application Artificial Intelligence based-anemia detection using palm image, accuracy, F1 score, precision, recall, sensitivity, specificity.

Additional outcome(s) None.

Data management Based on a search conducted using predetermined keywords in three databases, 921 articles were identified. These articles were subsequently entered to Mendeley Desktop and filtered based on duplicates and publication year, yielding a final set of 529 articles. Further filtering based on title and abstract yielded 33 articles suitable for full-text screening. The present study included 10 articles that met the established inclusion criteria. The selection of articles was conducted systematically using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) method and was documented in the PRISMA 2020 chart.

Quality assessment / Risk of bias analysis The risk of bias assessment was conducted by two reviewers (MMP and HK) and supervised by the third author (YWU). The QUADAS-2 tool was used as a reference for diagnostic accuracy, with its four main domains encompassing patient selection, index test, reference standard, and flow of patients through the study and timing of index tests and reference standards. Each domain is assigned a

rating of low, high, or unclear. The risk of bias is designated as low if all signaling questions are answered with "yes" in one domain. The use of a "no" response in a signaling question has the potential to introduce bias. The "unclear" category should be used only in instances where the available data are insufficient to facilitate an assessment (Whiting et al., 2011).

Strategy of data synthesis The present study used narrative synthesis based on the imaging modalities (i.e., photographs or videos), the population sample, the specific subtype of artificial intelligence, and the performance of an AI-based model for detecting anemia using palm images.

Subgroup analysis A synthesis of the relevant information from the studies included in this review was conducted, with the analysis focused on author, year of publication, research objective, dataset and data type, AI model used, and results, specifically model performance.

Sensitivity analysis None.

Language restriction English.

Country(ies) involved Indonesia.

Other relevant information The citation style used is American Psychological Association.

Keywords Artificial Intelligence, anemia, deep learning, machine learning, Palm.

Contributions of each author

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