NUTRIKEK-AI: PENGEMBANGAN DAN VALIDASI SISTEM PENDUKUNG KEPUTUSAN KLINIS HIBRIDA EXPLAINABLE AI UNTUK PREDIKSI RISIKO KEKURANGAN ENERGI KRONIS PADA IBU HAMIL

Ervina[1]*, Roichatul Djannah[2], Rahmat Nurcahyo[3], Dwi Yulianto[4]
[1]La Tansa Mashiro Midwifery Academy, Rangkasbitung, Lebak Regency, Banten, Indonesia
[2]Universitas Salakanagara Midwifery Academy, Tangerang, West Java, Indonesia
[3] Faculty of Information Technology, Latansa Mashiro University, Indonesia
[4] Department of Mathematics Education, Latansa Mashiro University, Banten, Indonesia

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ABSTRAK

Kekurangan Energi Kronis (KEK) pada ibu hamil masih menjadi persoalan kesehatan masyarakat yang serius, terutama di wilayah dengan keterbatasan sumber daya, karena berkaitan erat dengan stunting, anemia, resiko kehamilan dan persalinan. Skrining konvensional berbasis antropometri dinilai kurang mampu menangkap interaksi multidimensional antara faktor klinis, sosial, dan ekonomi yang memengaruhi status gizi ibu hamil, sementara sebagian besar model machine learning yang ada bersifat black-box sehingga sulit dipercaya oleh tenaga kesehatan. Penelitian ini bertujuan mengembangkan dan memvalidasi NutriKEK-AI, sebuah explainable hybrid clinical decision support system yang memadukan machine learning, Explainable Artificial Intelligence (XAI), dan pengetahuan klinis pakar untuk mendeteksi risiko KEK secara dini. Desain penelitian mengikuti kerangka Design and Development Research yang mengadopsi CRISP-DM dan Agile Development, melibatkan 214 ibu hamil, 18 tenaga kesehatan, dan 7 validator ahli di Kabupaten Lebak dan Pandeglang, Banten. Enam algoritma diuji dan dievaluasi melalui 10-fold cross-validation, analisis kalibrasi, validasi pakar, serta pengujian usability dan penerimaan pengguna. Model XGBoost menunjukkan performa terbaik dengan akurasi 88%, F1-score 0,85, dan AUC 0,91. Analisis SHAP mengidentifikasi Lingkar Lengan Atas, status anemia, indeks masa tubuh (IMT), dan status sosial ekonomi sebagai faktor risiko dominan. Sistem ini memperoleh validitas tinggi (S-CVI/Ave = 0,91), reliabilitas kuat (κ = 0,84), dan usability sangat baik (SUS = 84,6). Implementasi lapangan meningkatkan akurasi deteksi risiko dari 71,2% menjadi 88,4% dan mempercepat pengambilan keputusan dari 14,8 menjadi 6,3 menit. NutriKEK-AI terbukti akurat, transparan, dan mudah digunakan, sehingga berpotensi menjadi solusi berbasis AI yang efektif untuk mendukung deteksi dini dan pengambilan keputusan gizi maternal pada layanan kesehatan primer yang memiliki sumberdaya terbatas.

ABSTRACT

Chronic Energy Deficiency (CED) among pregnant women remains a pressing public health problem, particularly in resource-limited settings, given its close association with stunting, anemia, and adverse pregnancy outcomes. Conventional anthropometric screening struggles to capture the multidimensional interplay of clinical, social, and economic factors shaping maternal nutritional status, while most existing machine learning models remain black-box and are therefore

difficult for health workers to trust. This study aimed to develop and validate NutriKEK-AI, an explainable hybrid clinical decision support system that integrates machine learning, Explainable Artificial Intelligence (XAI), and expert clinical knowledge to enable early detection of CED risk. The study followed a Design and Development Research framework adopting CRISP-DM and Agile Development, involving 214 pregnant women, 18 health workers, and 7 expert validators in Lebak and Pandeglang, Banten. Six algorithms were tested and evaluated through 10-fold cross-validation, calibration analysis, expert validation, and usability and acceptance testing. The XGBoost model achieved the best performance, with 88% accuracy, an F1-score of 0.85, and an AUC of 0.91. SHAP analysis identified mid-upper arm circumference, anemia status, ANC visit frequency, and socioeconomic status as the dominant risk factors. The system demonstrated high validity (S-CVI/Ave = 0.91), strong reliability (κ = 0.84), and excellent usability (SUS = 84.6). Field implementation raised detection accuracy from 71.2% to 88.4% and shortened decision-making time from 14.8 to 6.3 minutes. NutriKEK-AI proved accurate, transparent, and easy to use, indicating its potential as an effective AI-based solution to support early detection and maternal nutrition decision-making in resource-limited primary healthcare settings.

**Corresponding Author: (anis.ervina87@gmail.com)*