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Potential of Artificial Intelligence in Electrocardiogram Analysis: A Systematic Review of Effective Algorithms for Cardiovascular Diseases Identification

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ABSTRACT

Introduction: Cardiovascular diseases (CVDs) are disorders affecting the heart and blood vessels. Early diagnosis of CVDs and timely intervention can prevent complications, enable prompt treatment, and reduce the burden of the disease on individuals and healthcare systems. Artificial intelligence (AI) has recently been utilized to analyze electrocardiogram (ECG) data to diagnose and classify CVDs. The present systematic review aimed to explore practical AI algorithms for analyzing ECG data to identify and classify CVDs.

Search Strategy: The study was conducted based on the PICO criteria and adhering to the PRISMA checklist. This review included a comprehensive search from 2020 to 2024 across the PubMed, Scopus, Web of Science, SID, and Magiran databases, as well as the Google Scholar search engine. The search utilized MESH keywords including "Diagnosis" , "cardiovascular disease" , "Artificial intelligence" and "electrocardiogram". Subsequently, two independent researchers screened the retrieved articles based on inclusion criteria.

Results: A total of 90 articles were identified through the initial search. Seven articles were finally included in the study. Most studies indicated that AI technology, utilizing specific algorithms, such as Convolutional Neural Network (CNN), Grasshopper Optimisation Algorithm (GOA), ResNet-50, and Gated Recurrent Unit (GRU), can facilitate early diagnosis and classification of CVDs by analyzing raw ECG data. In conjunction with the GOA algorithm, the CNN algorithm successfully identified and classified 16 categories of CVDs, with an accuracy of 99.58%, by analyzing ECG data. In this analysis, CNN extracted visual patterns from the data, while GOA assisted in fine-tuning its internal parameters to achieve higher accuracy. The ResNet-50 algorithm, a specific type of CNN, has also diagnosed and classified 27 categories of CVDs, with an accuracy of 97.63% using the skip connections mechanism and ECG data. Furthermore, using ECG data, the GRU algorithm effectively identified four categories of CVDs, with an accuracy of 58.90%.

Conclusion and Discussion: AI-based diagnosis and classification of CVD patients using ECG data holds promise for accurate and timely diagnosis and classification. Integrating AI technologies into healthcare practices can make the diagnostic process faster and easier, ultimately leading to better management of CVD patients. However, given the limitations of the studies conducted in this field, further and more diverse research is recommended.

Keywords: Artificial intelligence, Cardiovascular diseases, Electrocardiography