**Introduction**

The prevalence of vitamin deficiencies is a significant global health concern, affecting over two billion individuals worldwide and contributing to various health complications. Traditional methods of detecting vitamin deficiencies typically involve blood tests and laboratory analyses, which can be cost-prohibitive and inaccessible for many. Symptoms of these deficiencies can manifest visibly in different parts of the body, including the eyes, lips, tongue, and nails, presenting an opportunity for non-invasive detection through visual analysis.

Despite advancements in medical diagnostics, over 90% of populations in regions such as the UAE and the United States suffer from at least one vitamin or mineral deficiency. This issue is exacerbated by the widespread consumption of nutrient-poor processed foods and the declining nutritional content of produce due to soil depletion. Studies have shown a significant decrease in the mineral content of common vegetables over the past fifty years. Even with apparent food abundance in developed countries, deficiencies remain pervasive.

Given these challenges, there is a critical need for accessible, cost-effective methods for diagnosing vitamin deficiencies. To address this need, we introduce an innovative smartphone application that leverages artificial intelligence (AI) to detect vitamin deficiencies by analyzing images of specific body parts. This AI-based application empowers individuals to diagnose potential deficiencies without the need for blood samples or laboratory visits.

In our approach, we constructed a custom dataset consisting of images showing symptoms of various vitamin deficiencies. These images were collected and annotated to ensure the dataset's relevance and accuracy. Multiple state-of-the-art deep learning models, including EfficientNetV2L, InceptionResNetV2, MobileNet, ResNet, VGG16, and Xception, were employed to train the AI system. By using an ensemble of these models, we aimed to enhance the robustness and accuracy of the deficiency detection process.

The models were trained to recognize visual symptoms associated with deficiencies, such as changes in texture, color, and appearance of the eyes, lips, tongue, and nails. Each model contributed to the final prediction, ensuring a comprehensive analysis of the input images. After the initial detection phase, the outputs of these models were fed into a neuro-fuzzy system to refine the predictions and improve diagnostic accuracy.

The neuro-fuzzy system integrates the strengths of neural networks and fuzzy logic, allowing for nuanced decision-making based on the ensemble model outputs. This hybrid approach enhances the system's ability to handle the inherent uncertainties and variations in visual symptoms of vitamin deficiencies.

In summary, this model offers a practical solution to a widespread problem, potentially improving health outcomes by facilitating early detection and intervention for vitamin deficiencies. By making diagnostic tools more accessible, this model can help mitigate the health impacts of nutritional deficiencies and promote better public health awareness and dietary practices.