Towards Smartphone-Based Monitoring of Micronutrient Status

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Abstract

Micronutrient imbalance is a global issue, and its detection is invasive and expensive. Despite being largely preventable, imbalances of one or more micronutrients is pervasive and has major downstream health effects [1]. However, the true scope of this issue is often unseen and unaddressed because of the barriers to accessible micronutrient status assessment [2]. Status assessment of micronutrients is often done via indirect, subjective dietary logs, in-person clinical examinations, or complex analyses on blood (e.g. liquid chromatography-coupled mass spectrometry). While valuable, these assessments are expensive, flawed, and burdensome on the patient and the clinician.

As a step towards mitigating this barrier, we explore the application of mobile spectrophotometry to determine concentrations of three different B vitamins (B2, B7, and B12) in a solution. Spectrophotometry is the analysis of light (primarily visible light) as it is absorbed and transmitted by a constituent in a solution [5]. By analyzing how much light at a particular wavelength is absorbed by the sample, we can determine the relative concentration of a constituent or even its identity.

We experimented with multiple prototypes and design parameters (light sources and image processing techniques), finding that a design based on [3], modified with a custom cuvette holder attachment, was the best-performing. To extract absorbance spectra over the visible range (400 to 700 nm) from the smartphone camera (iPhone XR), we formalized an image analysis pipeline using ImageJ [4] and Python. Finally, we compared our results from the smartphone-based spectrophotometer to a laboratory device (Hach DR6000).

We found that vitamin B12 follows Lambert-Beer's law at distinct absorbance peaks (Fig. 1). Although results from the smartphone device exhibited high inter-trial variance, Lambert-Beer analysis demonstrated promising performance for determining unknown concentrations of vitamin B12 (R^2 of 0.913 vs 1.0 for the laboratory device).

CCS Concepts

• **Applied computing** → **Health informatics**; **Consumer health**;
• **Human-centered computing** → *Ubiquitous and mobile devices*.

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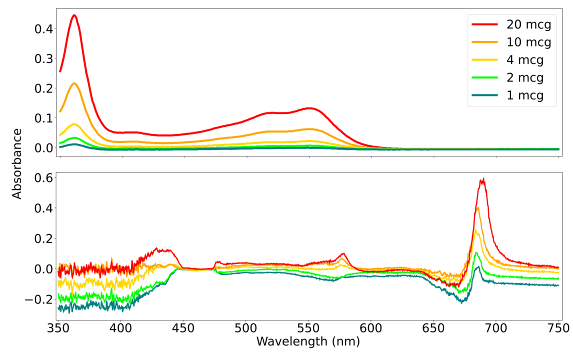

Figure 1: Absorbance peaks for different concentrations of Vitamin B12 at 361 & 551 nm for lab device (top) and 577 & 690 nm for smartphone device (bottom). Concentrations are mcg/mL

Keywords

mobile health, nutrition assessment, accessibility, spectrophotometry

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