VitalEdge: A Novel Non-Invasive Quadruple Biosensor and Health Risk Evaluation System for Early Disease Screening

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Metabolic disorders and malnutrition remain critical health concerns, often undiagnosed due to invasive, costly, and inaccessible testing methods. VitalEdge is a novel non-invasive biosensor that detects concentrations of testosterone, glucose, vitamin C, and lactate from a single saliva sample, enabling early diagnosis of prediabetes, PCOS, & scurvy, among others. The biosensor utilizes electrospinning, producing a scaffold embedded with nanofibers of biochemical-reagents shaped into test strips. Each biomarker undergoes a distinct colorimetric-reaction: testosterone forms a red-pink complex, glucose changes from yellow to brown, vitamin-C shifts from blue to colorless, and lactate changes from colorless to blue. The 3D-printed sensor, shaped like a '+' sign, has each arm (6.3*2.0 cm) dedicated to a biomarker. A 5 cm^3 diluted saliva solution is dropped into the central dropper-zone, from where engineered microfluidic-channels (5.2*0.4 cm) distribute it evenly across the test strips. A Health Risk Evaluation System (algorithm) then analyzes the colorimetric reaction in real-time, extracting the hue-values, comparing them to standard-curves, and providing instant biomarker-levels along with disease-risk insights. Our pilot studies demonstrated 96% accuracy compared to ELISA and HPLC, with specificity (95.2%), sensitivity (96.1%), repeatability (98.6%), and reproducibility (94.3%). The device also identified prediabetes and nutritional deficiencies in participants, which were later confirmed by lab tests enabling timely intervention. VitalEdge presents a scalable, cost-effective, and user-friendly diagnostic tool for large-scale screening, alleviating the burden on primary healthcare centers while transforming proactive health monitoring and preventive care.

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