One of the greatest challenges facing chronic disease management is the lack of a non-invasive continuous monitoring device that is small and comfortable enough to be worn daily by patients with conditions like peripheral artery disease and diabetes. Recently, photoplethysmography (PPG), a non-invasive monitoring technique that estimates arterial blood flow using light absorbance in tissue, has been widely applied in clinical settings due to its low cost, simplicity, and portability. Simultaneously, fluorescence lifetime measurement has also attracted attention as a method to non-invasively obtain physiological data from biosensor implants. Here, we combine these innovations to present a preliminary design for a novel multimodal sensor system that performs both PPG and lifetime measurements while remaining small enough for convenient everyday use. Our system utilizes a single highly-sensitive silicon photomultiplier to detect both PPG and lifetime signals, eliminating the need for separate sensors and boosting functionality without increasing size. In addition, we use a Bluetooth® microcontroller to convey the measured data to a mobile application for further ease of monitoring and build the system on flexible polyimide substrate for comfort and mobility. The final size of our device is 8.6 × 3.4 × 0.2 cm. We demonstrate positive results representing a significant advancement over existing technologies, showing that it is feasible to create a compact, multimodal continuous monitoring sensor system and reflecting a strong contribution towards the future of chronic disease monitoring.