Development of an Integrated Measurement System to Assess Physical Activity

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We are proposing to advance objective assessment methodology through development of an integrated measurement system to evaluate free-living physical activity (PA). The overall goal of this proposal is to develop and test new and innovative sensor technology to assess PA in the field over long periods of time with minimal subject burden and at relatively low cost. In addition to an accelerometer, which is commonly used in PA assessment research to measure body motion, we are proposing to use sensors that capture characteristics of breathing and the environmental context. Inclusion of these additional sensors ensures that the measurement system will objectively quantify GEI relevant features (e.g. exposure to environmental contaminants, indoor vs. outdoor activity) and increase the precision and validity of estimates of PA mode and the associated energy expenditure. A rigorous process of design optimization will be employed so that the final integrated measurement system (IMS) will be appropriate for use in large-scale epidemiological studies at a reasonable cost and with minimal subject burden. The specific aims are: 1) to design and develop a miniature self-contained IMS to assess physical activity. The device will include an accelerometer sensor, a ventilation sensor, and an environmental context sensor, which will determine if the activity takes place indoors or outdoors; 2) to calibrate the IMS during different types and intensities of indoor and outdoor physical activity; 3) to develop statistical data processing methods that will combine the information from the three streams of data (acceleration, ventilation and setting) to estimate physical activity mode and energy expenditure; 4) to validate the modeled estimates of physical activity mode and energy expenditure developed in Aim 3. We have assembled a multi-disciplinary team representing the fields of exercise physiology, electrical engineering, signal processing, mechanotronics, and statistics which provides us with the broad expertise needed to successfully carry out this project. These areas include expertise in sensor design and fabrication (electrical engineering, mechanotronics, signal processing), validation and calibration of the sensors during light, moderate and vigorous activity (exercise physiology) and development of appropriate statistical models to evaluate the performance of the various sensors and to develop and test activity pattern recognition systems. A field-deployable system will be complete at the end of Year 4.

Current Status: We have completed an initial literature review of all possible sensors for measuring ventilation and environmental context parameters. We have selected 2 sensors to further examine for each parameter. For ventilation, we are examining optical and piezoelectric crystal sensors; for environmental context we are examining a UV photodiode sensor and a user interface system where the user will respond to an LCD display prompt asking user if he/she is inside or outside. The electronics, power supply, and data storage systems are also in the design phase. We are designing these sensors that will undergo initial engineering and human testing to determine which sensor method for ventilation and environmental context we will ultimately use

in the multi-sensor device. We will incorporate a 3D accelerometer so that the final sensor will have 3 sensors.