Policy Forum

Measurement and Assessment of Physical Activity by Information and Communication Technology

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Abstract: This study provides explorative insights into the information and communication technology (ICT) for promoting the physical activity level. ICT has provided innovative ideas and perspectives for PA measurement, assessment, evaluation and health intervention. ICT that aims to increase exercise for the entire population should be of a well-oriented and easy-to-use design with the options of tailored and personalized feedback, coaching, and ranking and supporting; it should be capable of setting goals and working with a schedule and be accompanied by a website to provide overviews of the users' exercise results and progress.

Key words: Physical activity; Measurement; Assessment; Information and communication technology

INTRODUCTION

Sedentary behavior and physical activity (PA) are important issues of public health. It is well known that PA reduces the risk for cardiovascular diseases and diabetes and has substantial benefits for several conditions, including those that are associated with obesity, and that a passive lifestyle subsequently decreases the quality of life by increasing hypertension, obesity, and type 2 diabetes mellitus[1-2].

An overall evaluation of the evidence suggests that important health benefits accrue in most children and youths who daily accumulate 60 or more minutes of moderate to vigorous PA (MVPA). For adults and elderly individuals, risk reduction routinely occurs at levels of 150 min of at least moderate to intensity PA per week[3-4]. There is strong scientific evidence that regular PA extensively benefits the health in adults aged 18-64 years and in older adults aged ≥ 65 years. In some cases, the evidence of health benefits is the strongest in older adults because the outcomes related to inactivity are more common in them.

Globally, in 2010, approximately 23% of the adults aged > 18 years and more than 80% of the school-going adolescents aged 11-17 years had insufficient PA[5]. Therefore, it is important to increase the engagement in PA with the most effective methods to achieve this goal. The objective measurement and evaluation of the daily PA level is of great significance for the development of health interventions.

With rapid growth in Internet accessibility and improvements in technology, a growing population of research has employed information and communication technology (ICT), such as mobile health and wearable devices, to promote PA for addressing the increasing rates of obesity and chronic diseases. ICT has no universal definition, and it is related to technologies facilitating the transfer of information and various types of electronically-mediated communications. At the end of 2016, seven billion people (95% of the global population) were living in an area that had mobile-cellular network coverage, and it was estimated that globally there were approximately 3.6 billion mobile-broadband subscriptions[6]. So it is not surprising that research on the use of ICT intervention has escalated in the past decade.

Effective measurement is the basis and key for conducting relevant research. Measurement and assessment have been transformed from traditional methods to ICT, and precision and accuracy have also improved in practice. This article attempts to analyze various current measurement instruments and PA intervention researches to explore efficient methods among them to accordingly make recommendations for different populations to promote their PA levels and to focus on promoting further research in the field of public health.

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MEASUREMENT METHODS OF PA

Measurement methods of PA can be divided into subjective and objective evaluation methods. Subjective methods include diaries, logs, and questionnaires; e.g., international physical activity questionnaires. Subjective measurement, as part of a self-report survey, is the most extensively used. The most common method for assessing the PA level is the questionnaire, but as a subjective measurement method, several kinds of bias often occur[7], such as the recall bias to quantify PA for children and elderly individuals. Therefore, objective methods, such as accelerometers, provide a considerably greater precision of measurement[8]. Thus, seeking efficient methods to quantify PA has become a necessity.

Objective methods include observations, doubly labeled water (DLW), motion sensors (e.g., pedometers and accelerometers), and heart rate (HR) monitors. DLW is the most effective and reliable method to measure the total energy expenditure of free-living conditions, which is the gold standard[9-10]. HR monitors are based on physiological sensors which is useful as a physiological variable because it linearly and proportionately increases with exercise intensity and subsequently with oxygen uptake[11]. Some studies have concluded that the energy expenditure can be predicted from HR after adjusting for age, sex, and body mass[12], because of the low correlation between energy expenditure and HR in light-intensity PA.

Movement sensors (e.g., pedometers and accelerometers) report their outcomes in activity counts per unit of time, which are the product of the frequency and intensity of movement. Therefore, movement sensors not only can provide temporal information regarding specific variables, such as the total amount, frequency, and duration of PA[13], but also monitor the accumulation of MVPA and/or sedentary behavior with the development of population-specific cut-off points for activity counts per minute. Early pedometers were mechanical with a 2D-vibration sensor; currently, 3D-electronic pedometers have replaced them and have become a popular way for people to keep track of their recommended 10,000 daily steps; these are worn around the waist or on the wrist and include Omron™, Walking FIT™[14]. Among them, wrist pedometers, such as the Basis B1 health watch and Fit Flex, are popular and have been used as devices for monitoring PA. They are effective in detecting the total movement over a given timeframe, but may be less effective in distinguishing the types of PA. In other words, they might be effective in detecting the duration of walking or sitting, but are unable to detect cycling or the difference between sitting and watching TV/working[15]. However, cycling, which is classified as a MVPA, is poorly measured by accelerometers[16].

The growing affordable, multi-sensor technologies, including the combination of physiological, contextual, and motion sensors, seem to have a great potential in recording PA, sleeping time, HR, and other daily activities. Recently, the use of smartphones with applications (apps) or a WeChat tool has also become popular. The users need not buy any pedometer device because a smartphone directly provides the pedometer function. A comparative study of accuracy between pedometers, wearable devices, and smartphone apps reported the relative differences in mean steps during 500- and 1,500-step trails ranging from -0.3% to 1.0%, -22.7% to 1.5%, and -6.7% to 6.2%. Compared with actual step counts, data from wearable devices differed more than from smartphone apps[17]. Moreover, an assessment using a questionnaire overestimated PA strata than that using an objective method, such as using a pedometer[18]. Gradually, the development of ICT has provided new measures for assessing PA. The researchers have begun to try ICT methods, which are gradually being used in epidemiologic research to validate traditional methods, such as questionnaires (Table 1).

PA INTERVENTIONS THROUGH ICT

To address the growing rates of chronic disease and to affect the global burden of non-communicable disease, most interventions targeting behavior change that aim to improve PA have been developed[19]. Traditionally, face-to-face interventions (i.e., a structured PA program and counseling) are considered to be the optimal means for changing health-related behavior in group-based conditions because of their effectiveness in promoting fitness and exercise duration[20]. However, time constraints, cost limitations, geographic restrictions, and competing demands make inter-personal contacts difficult, and hence, such interventions are not effective in a large population[21-22].

Mass media (i.e., TV, radio, and advertisements) has been considerably used to guide and assist behavioral changes because it has the potential to assess large number of individuals, while the generic