

Original Research

Development and evaluation of an adult use-of-time instrument with an energy expenditure focus

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Abstract

Measurement in behavioural epidemiology depends on high resolution and precise and accurate measures of the behaviour of interest. Few questionnaires in the adult population are able to simultaneously collect the multidimensional information that is emerging as being important in the relationship between behaviour and health. This project had two objectives: (1) to develop an adult version of the computer-delivered Multimedia Activity Recall for Children and Adolescents (MARCA), a 24-h activity recall instrument that can measure use-of-time and estimate energy expenditure and (2) to determine the test–retest reliability and convergent validity of the developed adult MARCA. Thirty-eight healthy subjects (mean \pm SD, 31.7 \pm 12.1 yr) completed two recalls of the adult MARCA within 24-h and accelerometer counts were measured on 30 of the subjects. Bland-Altman analysis and intraclass correlation coefficients (ICC) were used to quantify the test–retest reliability of the adult MARCA. Spearman rank correlation coefficients (ρ) were used to quantify convergent validity of the adult MARCA compared to accelerometer counts. The test–retest reliability coefficients of the adult MARCA were high with intra-class coefficients ranging from 0.99 to 1.00. Moderate to strong validity was observed for physical activity level (PAL) (MET.min score of accelerometer wear time) and accelerometer counts per minute ($\rho = 0.72$). The adult MARCA is a valid and reliable self-report measure of use-of-time and energy expenditure, capable of a wide variety of flexible use-of-time analyses related to a wide range of behaviours.

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1. Introduction

Within behavioural epidemiology, the activity-health paradigm has received considerable attention and measurement of activity-related behaviour has been an ongoing challenge due to its complex and multi-dimensional nature.¹ Furthermore it is emerging that the link between activity-related behaviour and health is broader than physical activity alone. Recent research is emerging to suggest that other factors, including other types of activity (such as sedentary

behaviour)² and the way in which the activity is accumulated throughout the day, may independently affect health.^{3,4} Currently, measurement of activity-related behaviour is most commonly by self-report physical activity questionnaires, that address varying lengths of recall and domain of activity assessed. Currently, these methods continue to show limited validity⁵ and have difficulty in detecting the full range of activity-related behaviour and how it is accumulated. Furthermore, despite the documented advantages of some computer delivered instruments⁶ few of these have been developed for use with adults. In response to similar limitations in the children and adolescents, Ridley and colleagues⁷ developed the Multimedia Activity Recall for Children and Adolescents (MARCA), a use-of-time instru-

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ment for children with an energy expenditure (EE) focus. The MARCA is a computer delivered 24-h recall for children that adopts a time-diary approach, by asking respondents to sequentially recall their previous day in time slices of 5 min or more. Evaluation of the MARCA has shown high test–retest reliability ($ICC = 0.88–0.94$), convergent validity comparable to other self-report instruments when validated against accelerometry ($\rho = 0.36–0.45$) and evidence of good content and construct validity.⁷ While designed as a computer delivered self-administered instrument, the MARCA can also be administered by computer assisted personal interview or computer assisted telephone interview.

By combining a 24-h activity recall in a time-diary format, a compendium of energy costs and an analytical module, the MARCA is a high-resolution instrument that is capable of both use-of-time and EE analysis. However, there is currently no adult equivalent of this tool to provide these measurements of activity in adult populations.

Therefore, the adult MARCA was developed, modelled on the existing instrument for children. The purpose of this article is to describe the development and evaluation (test–retest reliability and convergent validity) of the adult MARCA.

2. Methods

Convenience samples were chosen for the combined reliability and criterion validity study ($n = 38$, 14 male, 24 female). English-speaking adults who could recall use-of-time and ambulated without aids that were over 18 years of age were recruited from the University of South Australia and the general public. Interested participants were given information sheets and invited to confirm their participation in the study via informed consent. Ethical approval for this project was gained from the University of South Australia Human Research Ethics Committee.

Modelled on the previously developed instrument for children,⁷ to complete the adult MARCA, respondents are asked to set anchor-points based on meal-breaks throughout the day by dragging icons across a timeline. Each of the subsequent screens of the MARCA then asks the user to report their activity in each of the segments, e.g. midnight to breakfast, breakfast to lunch etc. This is referred to as a segmented day format and allows recall of activities in the context and order in which they were performed, prompted by the anchor points.

Activity is reported by choosing from a list of over 300 activities, split into categories of inactivity, sport/recreation, occupation, self-care, home activities and other. Respondents indicate the duration of the activity using time sliders and then add the activity to the activity list. If the respondent chooses a locomotor activity they will also be asked to nominate its intensity (light, medium, hard).

Each activity in the MARCA is linked to a known energy cost in an associated compendium of EE through a unique six-digit code, which is continuous with the coding structure

of the children's MARCA.⁸ The energy cost of the activity is described in metabolic equivalents (METs), multiples of resting metabolic rate, and is adult-specific, based largely on the Ainsworth Compendium of Physical Activities.⁹ In addition, the allocated code also provides information about the characteristics of each activity [e.g. which category the activity is in, body position when performing the activity (sitting, standing etc.) and intensity of the activity].

The final component of the adult MARCA is the analytical module, which facilitates data analysis of collected profiles. The analytical module allows cleaning of data and scanning for evidence of implausible values. Due to the MARCA's activity coding structure and related compendium of EE, the programmable analytical module can yield a variety of analyses relating to both use-of-time and EE. The module can calculate: the individual's physical activity level (PAL) (the time weighted average of MET values over the day); time spent within a given MET range (e.g. time spent in physical activity ≥ 3 METs); and time spent lying down, sitting, standing or in locomotion. The module can also determine the number of minutes and estimated energy cost or time-distribution for an activity or set of activities for a single profile.

Major changes to modify the MARCA for use in adult populations included updating the graphic user interface, reducing the segmented day format to meal times only (in comparison to using school breaks, e.g. recess, home time) and reviewing the categories and activity list to ensure they reflected an adult lifestyle. Finally, the energy cost of activities was updated to reflect adult-specific MET costs, rather than the child-specific MET costs used in the children's MARCA.

Convergent validity of the adult MARCA was determined by comparing MARCA variables to accelerometry (MTI Actigraph accelerometer Model AM7164-2.2C, Manufacturing Technologies, Inc., Fort Walton Beach, FL [formerly distributed as Computer Science Applications]). The Actigraph is a small (5.1 cm \times 3.8 cm \times 1.5 cm) uniaxial accelerometer that measures vertical human movement and stores data over user-specified time intervals (epochs).¹⁰ The Actigraph has demonstrated reliability ($r = 0.98$ [11]) and validity compared to indirect calorimetry ($r = 0.56$, $p < 0.001$ [12]) in assessing activity in adults.

Data collection for each participant occurred over a 3-day period, with each participating in both the reliability and validity components of the project. On the first day of measurement participants were required to attend one appointment consisting of height and weight measures, collection of demographic data and fitting of the accelerometer.¹² Participants were not informed of the purpose of wearing the accelerometer or that they would be asked to recall their activity during the next day. Participants were given detailed instructions to wear the accelerometer from midnight of day 1 to midnight of day 2 and to remove it only during contact sports or when engaging in water activities.

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