The Energy Cost of Household Chores, Rollerblading, and Riding Scooters in 9- to 14-Year-Old Children

Kate Ridley and Timothy Olds

Background: To improve the scope of the *Youth Compendium of Energy Expenditures*, a range of everyday activities of varying intensity should be measured. This study measures the energy cost of children undertaking common household chores, rollerblading and riding a foot-propelled scooter. **Methods:** Participants were 9- to 14-year-old children. A metabolic cart was used to measure oxygen cost (VO_2) of a variety of household chores. A Cosmed K4b2 portable oxygen analyzer was used to measure VO_2 during rollerblading and riding a scooter at self-selected speeds. Energy costs for each participant were calculated as child METs. **Results:** Mean child MET costs for the household chores ranged from 1.3 to 3.6 METs. Rollerblading and riding a scooter yielded mean child MET costs of 6.5 and 6.3 METs respectively. **Conclusions:** Household chores were found to be of light to moderate intensity, while rollerblading and riding a scooter were vigorous activities.

Keywords: measurement, youth, metabolism

This manuscript reports the results of 2 separate studies investigating the energy cost of 2 categories of daily activity in children. The first study assessed the energy cost of common household chores. Although children in most Western countries¹ appear to spend little time doing chores, some groups of children spend significantly more time doing chores than others.² Given that these activities may involve intermittent walking, and the energy cost of walking is age-dependent,³ energy-cost estimates in children are particularly important. The second study assessed the energy cost of rollerblading (ie, in-line skating) and riding a foot-propelled scooter. As active transport in children continues to decline internationally and remains a target for intervention,⁴ accurate estimates of the daily contribution of these active transport modes are needed. Australian data suggest rollerblading and riding foot-propelled scooters remain active transport options for children, with 54% reporting in a national survey⁵ that they had participated in skateboarding, rollerblading or riding a scooter in the previous fortnight.

Methods

Participants

Convenience samples comprising healthy children between the ages of 9 and 13.5 years were recruited from local primary schools. Twenty-three children were recruited for Study 1 and 30 children for Study 2; however, the sample sizes varied for each measurement (Table 1). Both studies were approved by the Ethics Committees of the University. Informed consent was obtained from the schools and parents/caregivers, and assent from the children involved.

Ridley (Kate.Ridley@flinders.edu.au) is with the Sport, Health, and Physical Education (SHAPE) Research Centre, School of Education, Flinders University, Australia. Olds is with the Alliance for Research in Exercise, Nutrition and Activity (ARENA), School of Health Sciences, University of South Australia.

Activities

Study 1—Household Chores. All measurements were taken in a laboratory setting fitted to simulate a bedroom, kitchen and dining room. After a familiarization period, each participant was measured under 4 conditions: 1) making a bed and tidying a bedroom, 2) washing dishes, 3) setting and clearing a dinner table, and 4) hanging out washed clothes and removing them from a clothesline. Children were asked to perform each activity at the same pace they would ordinarily perform the activity at home. No attempt was made to control the speed of the activities and the order of measurement was randomized. Each participant was measured for at least 5 min in each chore and rested for at least 10 min between chores.

Study 2—Rollerblading/Riding a Scooter. All measurements were taken at 2 local primary schools in outdoor asphalt play areas. Children wore their own rollerblades and rode either their own nonmotorized scooter or a scooter provided by the researcher. Children were asked to wear the types of clothing and safety equipment they would ordinarily wear when riding scooters or rollerblading.

A straight 20 m course was measured on the asphalt play area. Timing light gates (Swift Dual Beam, Swift Performance Equipment, New South Wales, Australia) were used to record each participant's 20 m lap times. Children were asked to scoot or rollerblade through the 20 m straight course at a self-selected speed for 10 min. Children rested for at least 10 min in between activities. Measurements were undertaken at various times during the year, always in dry conditions. A subsample of the participants (scooter, $n = 13$; rollerblade, $n = 7$) were involved in a reliability trial to assess the reliability and intraindividual variation of the energy-cost measures. Participants completed a retest of either the scooter or rollerblade measurements between 1 and 14 days after the initial test. Students used the same equipment in both trials and received identical instructions.

Measures

Energy expenditure (EE) was measured using indirect calorimetry. Study 1 (household chores) used an automated gas-analysis metabolic

Table 1 Descriptive Characteristics of the Participants in Each Study (Mean $\pm$ SD)

Study	n	Gender	Age (yr)	Ht (cm)	Mass (kg)	RMR (ml·kg ⁻¹ ·min ⁻¹)
Study 1						
Household chores						
Setting the table	20	10 F/10M	11.9 $\pm$ 0.6	152.3 $\pm$ 8.4	43.5 $\pm$ 8.4	4.4 $\pm$ 0.5
Hanging out washing	14	5 F/9 M	11.6 $\pm$ 0.6	148.9 $\pm$ 6.3	40.5 $\pm$ 6.3	4.6 $\pm$ 0.4
Washing dishes	21	13 F/8 M	12.0 $\pm$ 0.7	153.2 $\pm$ 8.1	44.9 $\pm$ 8.4	4.2 $\pm$ 0.5
Making bed	17	10 F/7 M	11.9 $\pm$ 0.7	153.8 $\pm$ 7.9	44.4 $\pm$ 8.6	4.3 $\pm$ 0.5
Study 2						
Rollerblading	19 (26) ^a	6 F/13 M	11.1 $\pm$ 0.7	151.4 $\pm$ 9.9	44.0 $\pm$ 12.4	4.6 $\pm$ 0.4
Riding a scooter	30 (43) ^b	12 F/18 M	11.0 $\pm$ 1.2	150.4 $\pm$ 9.4	42.7 $\pm$ 11.8	4.7 $\pm$ 0.5

Abbreviations: RMR, resting metabolic rate predicted by Schofield age and mass equations (1985).

^a 26 rollerblade measures taken on 19 participants.

^b 43 scooter measures taken on 30 participants.

cart (Ametek, Newark, DE). VO₂ measured by this system was certified to be accurate to within $\pm 3\%$ when compared with an automated VO₂ calibrator. Study 2 (rollerblading/riding a scooter) used the Cosmed K4b2 portable open-circuit gas-analysis system (Cosmed, Rome, Italy). The Cosmed K4b2 system consists of a facemask and a gas-analysis hub, which was worn on each participant's back, attached via a shoulder harness and waist strap. Both the metabolic cart and Cosmed K4b2 system, including breath-by-breath capability, were calibrated before each test (in accordance with the manufacturer's recommendations). During each activity, gas-exchange variables (oxygen uptake [VO₂], minute ventilation [V_E], respiratory exchange ratio [RER]) were sampled at 30 s epochs using the metabolic cart, or breath-by-breath using the Cosmed K4b2. Averaged values from the time gas exchange reached steady-state until 30 s before the end of the activity (to avoid artifacts introduced by anticipation of the end of the activity) were used in the analyses. The amount of data used to determine the average values varied across individuals but at least 2 min of steady-state data (ie, the period after at least 3 min of activity where VO₂ and VCO₂ values varied by $< 15\%$) were used in each instance. The children's height and weight were measured in both studies. The weight of each child's rollerblades, safety equipment and the weight of the Cosmed K4b2 (600 g) were also added to the child's measured weight for energy-cost calculations.

Data Analysis

EE values were expressed as means and SDs. The percent coefficient of variation (%CV) for the VO₂ of each activity was calculated to provide a measure of relative interindividual variation. Child METs were calculated by dividing activity EE by the child's predicted resting metabolic rate (RMR) using the Schofield prediction equations based on the child's age, gender and mass.⁶ Unpaired *t*-tests were used to compare demographic variables and EE between boys and girls. Paired *t*-tests were used to assess whether significant differences existed between the test and retest VO₂ values during rollerblading and riding a scooter.

Results

The sample sizes, gender, mean (SD) age, height, mass and predicted RMR⁶ of the participants are presented in Table 1. There were no differences between male and female participants in age, height, mass, predicted RMR, oxygen cost or MET cost across the activities; as such, subsequent analyses were conducted with genders combined. The mean, SD and %CV for oxygen cost (VO₂) and child METs for each of the activities are presented in Table 2.

Linear regression analyses revealed moderate associations between VO₂ and speed in scooter riding ($r = .39$, $P = .01$, $n =$

Table 2 Oxygen Cost (VO₂), CV%, Child MET Cost for Each of the Video Center Games, Household Chores, and New Locomotions (Mean $\pm$ SD)

Activity	VO ₂ ml·kg ⁻¹ ·min ⁻¹	VO ₂ CV (%)	Child METs
Study 1			
Setting the table	11.4 $\pm$ 1.8	15.7	2.6 $\pm$ 0.5
Hanging out washing	11.7 $\pm$ 1.2	10.4	2.6 $\pm$ 0.3
Washing dishes	7.8 $\pm$ 0.9	12.1	1.9 $\pm$ 0.3
Making bed/tidying room	15.1 $\pm$ 3.4	22.7	3.6 $\pm$ 0.8
Study 2			
Rollerblading (mean speed = 2.4 m·s ⁻¹)	30.2 $\pm$ 9.4	28.0	6.5 $\pm$ 1.9
Riding scooter (mean speed = 2.5 m·s ⁻¹)	29.3 $\pm$ 6.1	23.1	6.3 $\pm$ 1.6

Abbreviations: CV, coefficient of variation; child MET, metabolic equivalent calculated as ml O₂·kg⁻¹·min⁻¹/RMR predicted by Schofield age and mass equation (1985).

41) and similar but nonsignificant associations between VO_2 and speed in rollerblading ($r = .31$, $P = .13$, $n = 26$). Paired t -test results revealed no significant differences in test-retest VO_2 values for either the rollerblade or the scooter analyses.

Discussion

The common household chores measured in this study were found to elicit light to moderate EEs in children. Many of the energy costs measured in the study were similar to those previously measured in children^{7–9} and adults.¹⁰ While most household chores would be considered of light intensity (ie, 1.5 to 2.0 METs), making the bed elicited a moderate intensity of 3.6 METs. Similar MET costs were reported in 2 other studies of bed making in children;^{7,8} however, the adult *Compendium of Physical Activities* reported a lower intensity of 2.0 adult METs.¹⁰ This difference may be due to the manner in which the activity was performed in each study, for example, there may have been differences in the speed at which the work was performed and/or the degree of extraneous movements (eg, the bed making in this study also involved some general tidying of the room). The differences may also result from children moving within an environment containing adult-sized furniture and therefore having to lift objects that are proportionally larger and heavier for children, and need to be moved further proportionally.

Rollerblading and riding a scooter were found to elicit vigorous EEs (6.3 to 6.5 METs). Another published study measuring riding a foot-propelled scooter also reported a slightly lower, yet still vigorous, energy cost of 4.6 to 5.3 METs in 8 to 12 year old girls (but speed was not reported in the study). The EEs measured while rollerblading were lower than those reported in the adult *Compendium* (7.5 to 14.0 METs)¹⁰ using faster speeds (4.0 to 6.0 $\text{m}\cdot\text{s}^{-1}$, compared with 1.4 to 3.6 $\text{m}\cdot\text{s}^{-1}$ in this study). There were no strong relationships found between the speed and energy cost of these locomotor activities in this study. The movement patterns and associated efficiencies involved in riding scooters and rollerblading vary among individuals and are probably associated with level of experience.

The data collected in these studies will assist in improving the breadth and depth of the *Youth Compendium of Energy Expendi-*

tures, hence assisting researchers to estimate EE in children more accurately using reported or observed behavior.

References

1. Harrell JS, Pearce PF, Markland ET, Wilson K, Bradley CB, McMurray RG. Assessing physical activity in adolescents: common activities of children in 6th–8th grades. *J Am Acad Nurse Pract*. 2003;15(4):170–178. [PubMed doi:10.1111/j.1745-7599.2003.tb00259.x](#)
2. Ferrar K, Olds T, Maher C. More than just physical activity: time use clusters and profiles of Australian youth. *J Sci Med Sport*. 2013;16(5):427–432. [PubMed doi:10.1016/j.jsams.2012.11.885](#)
3. Ridley K, Olds TS. Assigning energy costs to activities in children: a review and synthesis. *Med Sci Sports Exerc*. 2008;40(8):1439–1446. [PubMed doi:10.1249/MSS.0b013e31817279ef](#)
4. Tremblay MS, Gray CE, Akinroye K, et al. Physical activity of children: a global matrix of grades comparing 15 countries. *J Phys Act Health*. 2014;11(Suppl 1):S113–S125. [PubMed doi:10.1123/jpah.2014-0177](#)
5. Australian Bureau of Statistics. *Children's Participation in Cultural and Leisure Activities*. Canberra, Australia. 2012.
6. Schofield W. Predicting basal metabolic rate, new standards and review of previous work. *Hum Nutr Clin Nutr*. 1985;39C(1):s5–s41. [PubMed](#)
7. Crouter SE, Horton M, Bassett DR, Jr. Use of a two-regression model for estimating energy expenditure in children. *Med Sci Sports Exerc*. 2012;44(6):1177–1185. [PubMed doi:10.1249/MSS.0b013e3182447825](#)
8. Lazer S, Busti C, Galli R, et al. Physical activity ratios for various commonly performed sedentary and physical activities in obese adolescents. *J Endocrinol Invest*. 2009;32(1):79–82. [PubMed doi:10.1007/BF03345684](#)
9. Rieper H, Karst H, Noack R, Johnsen D. Intra- and inter-individual variations in energy expenditure of 14–15-year-old schoolgirls as determined by indirect calorimetry. *Br J Nutr*. 1993;69(1):29–36. [PubMed doi:10.1079/BJN19930006](#)
10. Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 Compendium of Physical Activities: a second update of codes and MET values. *Med Sci Sports Exerc*. 2011;43(8):1575–1581. [PubMed doi:10.1249/MSS.0b013e31821ece12](#)