

# FINAL REPORT:

## Youth Compendium of Energy Expenditures Update: Walking and Running data

Dr Kate RIDLEY

Sport, Health and Physical Education (SHAPE) Research Centre  
School of Education,  
Flinders University.

### 1.0 INTRODUCTION

---

The Youth Compendium of Energy Expenditures Update project was funded by FHI 360/National Collaborative on Childhood Obesity Research (NCCOR): FHI 360 Reference Project No. #PO15001973 and NIH Office of Disease Prevention.

In 2013 Dr Kate Ridley from the SHAPE Research Centre at Flinders University, Adelaide, Australia undertook a systematic review of the energy cost of everyday activities in children to update the Youth Compendium of Energy Expenditures, funded by NCCOR. This systematic review excluded the activities of walking, running and cycling.

The current project further works toward an update edition of the Youth Compendium of Energy Expenditures to include walking and running manuscripts by providing a new systematic literature search. The agreed deliverable tasks are:

1. Provide a list of included **walking and running** EE studies delivered in a bibliographic management program
2. Supply Draft data set (supplied in Excel spreadsheet) containing mean data for subject descriptive variables (n, age, weight, etc) information for each sample and energy costs converted to the common unit of VO<sub>2</sub> in ml.kg<sup>-1</sup>.min<sup>-1</sup> for each measured speed.
3. Supply summary report containing methods and summary results for review by scientific advisory board
4. Supply revised dataset after feedback from scientific advisory board.

This report presents the draft results of the 2015 walking and running systematic review. The report outlines the methods undertaken; provides the summarized energy cost data in a separate Microsoft Excel spreadsheet and provides a summary of extracted data in relation to age and speed.



Dr Kate RIDLEY  
6<sup>th</sup> May 2016.

## 2.0 METHODS

---

The methods used in the 2013 systematic literature search of the energy cost of children's activities are outlined below (#s1-6). During this search, manuscripts that solely reported the energy costs of walking and running were separated and stored for analysis in walking and running systematic review.

### **2.1 Eligibility criteria**

Studies that met the following criteria were included in the review:

1. full-text article, thesis/dissertation, or data provided from authors from a published conference abstract;
2. not a systematic review or meta-analysis (all relevant systematic reviews and meta-analyses were screened for references before being subsequently excluded);
3. provided child/youth human (<18 y) data;
4. energy cost/expenditure (EE) of walking and running were measured at unique set speeds (i.e. not a range of self-selected\*\* or researcher determined speeds where mean speed was reported);
5. numerical energy cost data measured using a criterion method (i.e. indirect calorimetry, direct calorimetry and CO<sub>2</sub> breath tests) were provided;
6. participants were not selected based on specific pathology (excluding weight status).  
Note: where studies compared a control of non-pathological participants to a sample based on a specific pathology data extracted for the control sample.

\*\*Data from self-selected (or self-paced) data have been extracted into a separate file for future analyses where the most typical and range of self-selected walking and running speeds will be investigated. This information will assist in determining the most appropriate speed ranges to be incorporated into the compendium. When children self-report or are observed for physical activity quantification purposes, qualitative descriptors of walking and running are often used (e.g. "slow", "normal", "fast") and will need to be interpreted in order to assign a MET cost from the compendium.

### **2.3 Search strategy**

A list of search terms was created and approved by the SAC. Two separate searches were undertaken.

The aim of the first search was to locate studies where the primary aim was to measure the energy cost of individual activities in children.

#### **Search 1 search strategy:**

##### *Block 1:*

child\*, teen\*, adolescen\*, young\*, youth\*, pube\*, pediat\*, paediat\*, girl\*, boy\*

##### *Block 2:*

"energy cost", "energy expenditure", "caloric expenditure", "oxygen consumption", "aerobic demands", "oxygen uptake", "metabolic cost".

The terms within each block were combined with the Boolean command OR. Blocks were combined with the Boolean command AND.

The aim of the second search was to locate studies where the primary aim was to validate activity monitors (e.g. accelerometers, pedometers, etc.) using a protocol where the energy cost of individual activities in children were measured.

**Search 2 search strategy:**

*Block 1:*

child\*, teen\*, adolescen\*, young\*, youth\*, pube\*, pediat\*, paediat\*, girl\*, boy\*

*Block 2:*

“acceleromet\*”, “pedomet\*”, “heart rate”, “activity monitor”

*Block 3:*

“valid\*”

The terms within each block were combined with the Boolean command OR. Blocks were combined with the Boolean command AND.

## **2.2 Information Sources**

Studies were located primarily via electronic databases. The following databases were searched: CINAHL; Cochrane library; EMBASE; Medline; Proquest; PsychINFO; SCOPUS; SportDiscus; and Web of Science. In addition, reference lists of relevant reviews were scanned and some studies were located through contact with academic colleagues. No limits were applied for languages.

Two separate searches were undertaken trained researchers (n=2). Results were compared and no disparities were found (i.e. identical search results were found). Searches were undertaken on 20 March 2013. Once each database search was completed all studies were compiled into a single list with EndNote bibliographic software with all duplicates removed.

## **2.3 Study Selection**

Trained researchers carried out eligibility assessment in a standardized manner, each screening one half of the list. Title, abstracts and keywords were assessed for initial eligibility. Those abstracts that met the eligibility criteria, or abstracts where more information was required prior to a decision regarding inclusion was made, were retrieved as full text. All studies retrieved as full text were then thoroughly assessed for inclusion. Any queries regarding eligibility were referred to the Principal Researcher (Dr. Kate Ridley) for resolution. Authors were contacted where possible to obtain missing data, clarify aspects of the study (e.g. protocol), etc.

## **2.4 Data Extraction**

Selected demographic and energy cost variables were then imported into an Excel spreadsheet. Description of the variables extracted onto the spreadsheet can be found in Table 1.0. Where studies reported multiple metrics of energy cost data, the following hierarchy was used to determine which metric to report in the Summary Data Spreadsheet: 1) VO<sub>2</sub>; 2) KJ; 3) KCal; 4) METs (authors contacted in an attempt to obtain gross energy cost data when METs reported).

## 3.0 RESULTS

---

### **3.1 Search results**

The walking and running search yielded 75 studies that met inclusion criteria. A total of 347 unique mean values for selected speeds were extracted (shown in rows in the Excel spreadsheet).

### **3.2 Systematic review results**

The results of the systematic review can be found in the supplementary Excel Spreadsheet “YouthEESystematicReviewData\_WalkRun\_6May2016.xlsx” file. The first worksheet in the spreadsheet (labeled “Included Studies”) provides the full reference for each included study. The second worksheet (labeled “Data”) provides the summary data for the extracted variables. Asterisks (\*) were used where the relevant data were not provided within the publications.

The *Filter* function in Excel can be used to restrict the view to variables of interest (e.g. all data for a chosen age range). To undertake filtering, select the entire spreadsheet and then click filter. Once filtering is turned on, click the arrow in the column header to choose a filter for that column.

Of the 347 unique mean values, 189 were measured during flat treadmill walking, 4 during paced over-ground (track) walking, 3 walking carrying a load, 127 during flat treadmill jogging or running, 3 during over-ground running; and 2 during running carrying a load. A total of 19 values involved running or walking on a gradient (% gradient reported).

A summary of the age/ treadmill speed combinations (excluding the over-ground and carrying load data) studied are shown below in Table 3.0.

Note: Data from overweight and obese samples have been extracted.

**Table 1.0 Description of the extracted variables**

<b>Variable name</b>	<b>Variable descriptor</b>
<b>Article ID</b>	A unique ID number for each article derived from the initials of the first author (first name, surname), the year of publication, an underscore_ followed by the first page number of the publication, e.g: AA2012_994.
<b>Year of pub</b>	Year of publication
<b>Age (mean)</b>	Mean age of the sample/stratum <i>Grey italicised data is a median value calculated from the reported range.</i>
<b>Age (SD)</b>	Standard deviation (SD) of the age of the sample/stratum
<b>Age (range)</b>	Range of ages within the sample/stratum
<b>n</b>	Sample/stratum size
<b>n M</b>	Number of males within the sample/stratum
<b>n F</b>	Number of females within the sample/stratum
<b>Strata</b>	A description of the stratum to which the data within the row belongs, e.g. boys/girls; age groups; strata determined by weight status (ow/ob, etc). ES = entire sample.

<b>Additional strata?</b>	A y/n (yes/no) variable that specifies whether the data in the row have already been provided in the spreadsheet within another strata (i.e. "y"). For example, a publication may present the mean data of the entire sample (ES), and then stratify these data and present means by age group. The rows that contain the ES data will be designated "n" and the rows that contain the age group data will be designated "y". This variable can be used to filter out replicated data using Excel's Filter tool option for the purpose of calculating total n's, weighted means for the entire sample, etc.
<b>mass (kg) (mean)</b>	Mean mass in kg of the sample/stratum <i>Grey italicised data is a weighted mean value estimated for an entire sample calculated where data were presented for males and females separately .</i>
<b>mass (kg) (SD)</b>	SD of the mass in kg of the sample/stratum
<b>height (cm) (mean)</b>	Mean height in cm of the sample/stratum
<b>height (cm) (SD)</b>	SD of the height in cm of the sample/stratum
<b>Schofield group</b>	The age range that the row of data sit within to determine which Schofield prediction equation will be used: Boys 3- 9 y, Boys 10-18 y; Girls 3-9 y, Girls 10-18 y. Where demographic data were not presented split by sex, the notations BG 3-9 y and BG 10-18 y were used and a weighted mean calculated.
<b>Schofield RMR (MJ/day)</b>	RMR in MJ/day predicted using the Schofield equations.
<b>Schofield RMR (VO2 ml/kg/min)</b>	RMR predicted by the Schofield equation converted to VO2 in ml/kg/min.
<b># of measures (if different to n)</b>	The number of energy cost measures undertaken for the activity designated in this row. This may vary from the n of the sample/stratum (column F) when either 1) repeated measures have been taken on each individual or 2) measures were not taken on every participant (n) <i>but</i> demographic details only provided for n. This variable should be used to calculate n for the purpose of calculating weighted mean energy costs.
<b>Activity Category</b>	A short descriptive name of the activity (e.g. walk/run/jog, etc) undertaken for which energy cost has been measured, based on the authors' description/naming of the activity.
<b>Speed</b>	Speed (numerical) in the units reported in the study
<b>Units</b>	The unit of speed (text) reported in the study
<b>Speed conversion 1</b>	Speed converted to kilometers per hour
<b>Speed conversion 2</b>	Speed converted to metres per second
<b>Gradient</b>	The % gradient reported in the study
<b>E Cost measure</b>	The method used to measure energy cost data, i.e: indirect calorimetry or direct (room) calorimetry. Further information regarding the type of indirect calorimetry equipment used (e.g. portable analyser, Douglas Bags, a metabolic cart, etc) can be sourced from the data extraction sheets. Note: While the data extraction forms also provided an option for CO <sub>2</sub> breath tests, the only publications that used this measure also measured energy cost using indirect calorimetry, therefore this measure was extracted.

<b>E cost unit</b>	The unit/metric that was used to present energy cost data. Where multiple metrics were provided, the following hierarchy was used to extract data: 1) VO <sub>2</sub> ; 2) KJ; 3) KCal; 4) METs.
<b>Measured E cost (mean)</b>	Mean energy cost for the designated activity and sample/stratum in each row.
<b>Measured E cost (SD)</b>	SD of the energy cost for the designated activity and sample/stratum in each row.
<b>Other measure of variability</b>	Any other measure of variability provided in the paper. The type of variability measure (e.g. range, %CV) is listed in the Notes column.
<b>Predicted Schofield RMR</b>	A duplicate column containing the RMR predicted by the Schofield equation converted to VO <sub>2</sub> in ml/kg/min.
<b>RMR prediction code</b>	Code (A through F) that indicates what data were used to predict RMR and MET costs. Table X presents a flow chart of calculation decisions to enable MET calculation.
<b>Notes</b>	Relevant notes regarding the data presented in the row are listed here.
<b>Converted to <math>\dot{V}O_2</math> ml.kg<sup>-1</sup>.min<sup>-1</sup></b>	Where possible, energy cost data not provided as $\dot{V}O_2$ ml.kg <sup>-1</sup> .min <sup>-1</sup> are converted to this base metric for comparative purposes. Data not provided per unit mass were converted using the mean mass provided. Data presented in KCal were first converted to KJs using the correction factor of 1 Kcal = 4.18 KJ. KJs were converted to VO <sub>2</sub> using a standard energy equivalent for oxygen uptake: 20.9 kJ.L <sup>-1</sup> O <sub>2</sub> .
<b>MET cost</b>	The MET cost was calculated by dividing the measured energy cost by the estimated RMR calculated using the age-, sex- and mass-specific Schofield prediction equations.

**Table 2: Flow chart of calculation decisions to enable MET calculation (activity  $VO_2$ /resting  $VO_2$  estimated by Schofield).**

Notation	Energy cost stratified by sex	Mass reported	Mass stratified by sex	N provided for M/F	Calculation of Schofield estimated RMR	MET Calculation for each sample
<b>A</b>	✓	✓	✓	✓	1. Sex specific RMRs calculated using sex specific mean masses	Sex specific mean activity $VO_2$ / sex specific mean Schofield predicted resting $VO_2$
<b>B</b>	✓	✓	✗	✓	1. Sex specific RMRs calculated using entire sample mean mass	Sex specific mean activity $VO_2$ / sex specific mean Schofield predicted resting $VO_2$ (calculated using mean mass across entire sample)
<b>C</b>	✗	✓	✓	✓	1. Sex specific RMRs calculated using sex specific mean masses 2. A weighted mean RMR calculated for entire sample	Entire sample mean activity $VO_2$ / weighted mean Schofield predicted resting $VO_2$ (calculated using sex-specific masses)
<b>D</b>	✗	✓	✗	✓	1. Sex specific RMRs calculated using entire sample mean mass 2. A weighted mean RMR calculated for entire sample	Entire sample mean activity $VO_2$ / weighted mean Schofield predicted resting $VO_2$ (calculated using mean mass across entire sample)
<b>E</b>	✗	✓	✗	✗	1. Sex specific RMRs calculated using entire sample mean mass assuming a 50/50 M/F sample 2. A weighted mean RMR calculated for entire sample assuming a 50/50 M/F sample	Entire sample mean activity $VO_2$ / weighted mean Schofield predicted resting $VO_2$ (calculated using mean mass across entire sample)

Note: Schofield equations are also different for age groups: 3-9 & 10-18. Mean age was used to determine which Schofield equation to use (even if wide variability).

**Table 3: Summary of the age/speed combinations studied. Top number = number of studies, Bottom number in parentheses = total number of unique mean values.**

		Speed (km/h)											
		1-1.9	2-2.9	3-3.9	4-4.9	5-5.9	6-6.9	7-7.9	8-8.9	9-9.9	10-10.9	11-11.9	12-12.9
Mean or median age	4.00-5.99	1 (3)					1 (1)						
	6.00-9.99	2 (3)	3 (8)	8 (12)	19 (33)	7 (11)	13 (18)	1 (1)	13 (17)	4 (4)	5 (5)		
	10.00-12.99	2 (2)	7 (9)	6 (7)	18 (26)	9 (13)	10 (16)	7 (11)	14 (28)	4 (5)	4 (5)	1 (1)	1 (3)
	13.00-15.99		2 (2)	4 (5)	9 (9)	8 (8)	2 (2)	3 (5)	11 (17)				1 (3)
	16.00-17.99				3 (3)	1 (1)	1 (1)		4 (8)	2 (4)		1 (1)	4 (5)



## 4.0 Comparison with 2008 Youth Compendium walking and running values

---

The 2008 Youth compendium cites child MET values estimated using an age and speed determined prediction equation published by Ridley and Olds in 2008. The prediction equation was based on EE values published in 37 studies. Of these 37 studies, 24 have been included in the current review. The remaining 26 were not included due to stricter inclusion criteria (ie. self-selected speeds, CO2 breath test determined EE and values estimated from Figures were excluded).

### Attachments

1) YouthEESystematicReviewData\_WalkRun\_6May2016xlsx

Any queries regarding the Youth EE Systematic Review Data or Report are welcomed and can be directed to Dr. Kate Ridley.



May 6<sup>th</sup>, 2016.