Public Health Nutrition: 18(9), 1578–1581 doi:10.1017/S1368980014003322

Invited Commentary

Beyond the randomised controlled trial and BMI – evaluation of effectiveness of through-school nutrition and physical activity programmes

First published online 14 January 2015

Gabriela Mistral, a Chilean poet who received the Nobel Prize for literature in 1945, wrote:

> *Many things we need can wait. The child cannot. Now is the time his bones are formed, his mind developed. To him we cannot say tomorrow, his name is today.*

Evidence has been slow to accumulate that school physical activity and nutrition interventions are effective at slowing the rate of physical growth and reducing the prevalence of obesity in children. This is in part because of the need for randomised controlled trials (RCT) that meet strict quality criteria. In addition, the focus on BMI-for-age criteria to define obesity and overweight, and therefore the outcome of 'effective' interventions, is a pragmatic measure but may be flawed in that the child's nutritional and functional status may have improved but BMI may not change. For a population, BMI is a measure of energy balance; it is not a measure of the many other factors that are required for optimal growth, development and function. In this commentary we describe a large-scale intervention utilizing an alternative measure of programme effectiveness. We believe the model and measure can be applied in different contexts to evaluate effectiveness of a programme to improve health in children in a school setting.

Time to run 550 m as an outcome measure

Alternative measures of the progress and effectiveness of interventions are required to speed translation of health-care research into practice[1,2]. Our work in this area developed largely in the form of Project Energize[3], a region-wide whole-of-school nutrition and physical activity programme in the Waikato region of New Zealand funded by the Waikato District Health Board. The Energize programme started as an RCT in 124 primary schools in Waikato between 2004 and 2006[3] and has now extended to all (*n* 242) primary and intermediate schools in the region.

In 2011, 5 years after completion of the RCT, an evaluation including more than 5000 children showed significant reductions in the prevalence of overweight and obesity in comparison with historical controls[4]. In addition, time taken to complete a 550 m run ($T_{550\,m}$) was measured as an indicator of fitness. The $T_{550\,m}$ is a validated measure of cardiorespiratory fitness[5]. Low physical fitness is associated with metabolic risk[6,7] and is a measure of physical function. Theory would predict that a functional measure of effectiveness of an intervention would be a better measure of health-related quality of life[8] than a measure of BMI.

For this evaluation, children of similar run speeds were continuously encouraged to run as fast as they could five times around an oval grass track (26·5 m × 42·5 m). While each child was measured only once in this test, others have shown the test to be reliable across a range of ages[9,10]. In all, $T_{550\,m}$ was measured in 5057 Waikato children (36% Māori, 2652 girls and 2405 boys) aged 6–12 years. Mean run time was found to be 12 % less in the Energized children than in a group of similarly aged children from another region who were comparable with respect to socio-economic status[4]. Also worth noting is that BMI of the Waikato children explained only 30 % of the variation in run time after accounting for age and gender[11]. Clearly BMI does not completely explain variation in run times and therefore physical fitness.

Development of reference centiles

To establish whether the 550 m run can be used as an effective measure of health-related functional change, run time data from the 2011 Energize children were used to develop reference centiles. Following the method of Cole and Green[12], the LMS (lambda, mu, sigma), representing skew (L), the median (M) and the CV (S), were derived and normalized by every age of measurement for the centile chart. Parameters were calculated separately for each gender. Thus, gender-specific, smoothed reference centile curves across an age range could be produced. The LMS method allows the conversion of measurements (even extreme values) into age-specific centile values. The software package lmsqreg in R version 2·12 was used to

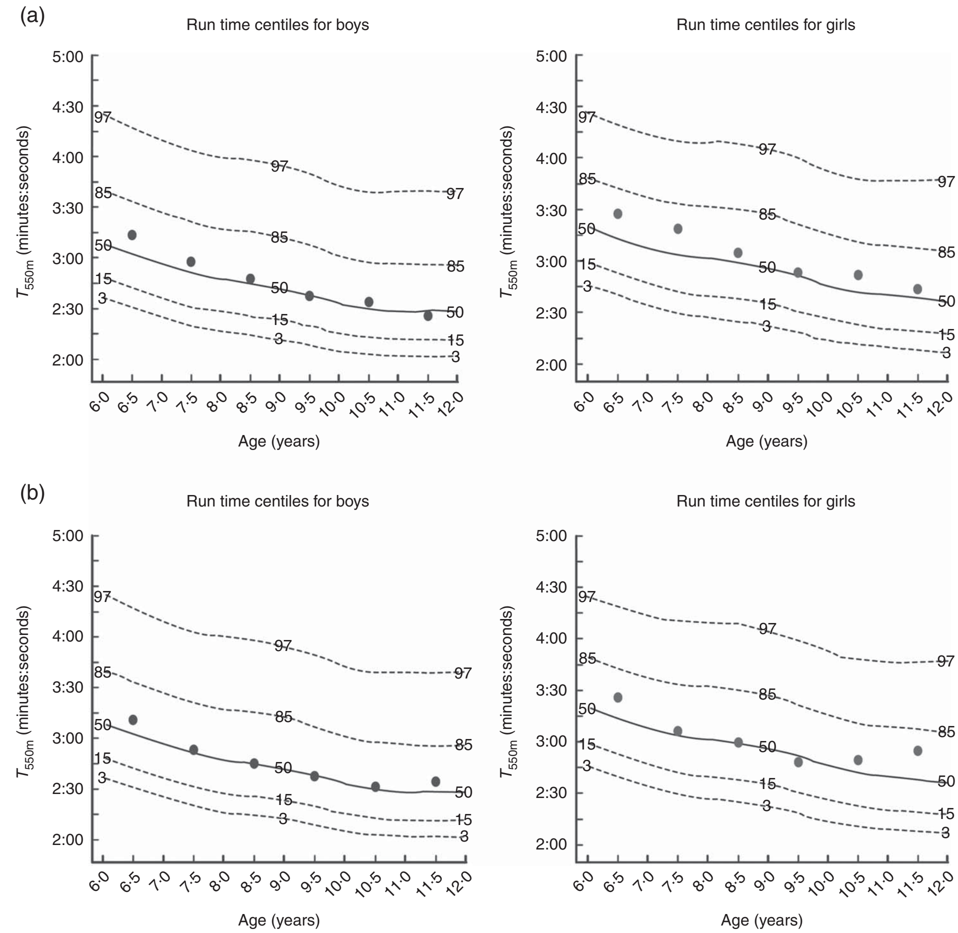

Fig. 1 Baseline measures of median time to run 550 m ($T_{550\,m}$) by age (●) compared with the reference 2011 Energize centiles (– – –, 3rd, 15th, 85th and 97th; ——, 50th, median) for two clusters of children in New Zealand, 2013: (a) cluster 1; (b) cluster 2

perform LMS regression. An Excel™-based tool to assess the Waikato 2011 centile and *Z*-score of child, classroom or school was also developed and is available at the AUT University Scholarly Commons[13].

Fixed centile curves showing the 3rd, 15th, 50th, 85th and 97th centiles (Fig. 1) for $T_{550\,m}$ for Waikato 2011 boys and girls aged 6–12 years were plotted separately. Time to run ranged from 2 to 5 min. At all ages the median time to run for girls was greater than that for boys. For both genders $T_{550\,m}$ declined with age; it is expected that children will run faster as they age because both skeletal muscle mass and stride length increase.

Application of reference centiles

In 2013 the Energize programme was introduced into two new clusters of schools from other regions of New Zealand, and baseline measures of $T_{550\,m}$ were recorded between February and May 2013. The two roll-out clusters differed in ethnic profile: 25 % *v*. 85 % Māori (cluster 1 *v*. cluster 2, respectively). In cluster 1, $T_{550\,m}$ was measured for 2205/2446 (90 %) and in cluster 2, for 1152/1742 (66 %) of the school roll. The median $T_{550\,m}$ centile for each year of age (median age assumed as 0·5-year interval) was overlaid on the Waikato 2011 centiles separately by cluster and gender (Fig. 1). Of the twenty-four points plotted (●), only one was less than the Waikato 2011 50th centile and the median run speed for children aged <7 and >10 years was, except for boys in cluster 1 at age 11·5 years, more than the Waikato 2011 reference. There are plans to reassess after two years of intervention using the 550 m run as a measure of health-related functional change.

Implications

The assessment of effectiveness of through-school physical activity and nutrition interventions relies largely on parental consent for longitudinal measurements of both weight and height and the derivation of BMI to compare against a reference to adjust for age and gender[14]. Centile curves for the $T_{550\,m}$ offer an alternative, useful tool that accounts for variation between girls and boys and the effects of growth and ageing on cardiorespiratory fitness. Used in conjunction with other measures of effectiveness

https://doi.org/10.1017/S1368980014003322

and engagement with a physical activity and nutrition programme or health service, these centile charts[13] can provide users with a novel tool to assess baseline measures and then the impact of an intervention accounting for gender and age. This may be particularly useful for those without access to statistical support.

Strengths of this method are that weight, height and exact age did not need to be measured, a large proportion of children in the schools participated in the assessment as consent was not required, and the assessment was not arduous and did not require a large amount of resourcing. Immediate information was available within each school and to the interventionist (Energizer) about the children's ability to run. Further work needs to be done to determine the intra-individual variation in the measurement and inter- and intra-observer errors in timing.

Ethical considerations

In New Zealand and Australia, ethics committee approval and informed consent from caregivers and the child are required for physical measures. This means that where consent is required, the findings are biased towards those who do consent. Arguably those who do not consent to be measured are the ones who would be benefiting from the intervention the most[15]. In the case of the 2013 Energize programme roll-out, the AUT University ethics committee confirmed that the aggregated and de-identified data (age and gender only provided) collected in the school clusters did not require ethical approval or informed consent, as they were collected as part of programme delivery and good practice, and were to be used to identify need for intervention. Thus, a whole-school approach of the intervention with the school cluster as the treatment unit means that no child, or teacher, or family is left out.

Conclusion

There is an urgent need to address the child obesity epidemic in practical and cost-effective ways. Furthermore, there should be accountability of all health services to show continued engagement with the community, reach and effectiveness of the service – all evaluated in a timely fashion to allow the service to be modified. We assert that ability to run faster is a measure associated with improved nutrition and body composition, and monitoring of effective translation of research into sustainable public health interventions can use measures such as $T_{550\,\mathrm{m}}$. The $T_{550\,\mathrm{m}}$ is a feasible, practical, socially and ethically acceptable measurement to evaluate the effectiveness of interventions to improve aerobic fitness within a cluster of schools over time.

Further, the centile charts provided here[13] could be a useful way to monitor change within schools or clusters over time and may also be used to track relative change for an individual. We believe that this tool would be useful for children of this age in various settings and countries. The graphics and the website link (AUT University Scholarly Commons) also provide a contemporary snapshot of time and place so that future trends in fitness can be easily monitored. Other tools and means of evaluation such as this need to be shared in order to achieve progress in the mission to have children who eat healthfully, are active and have fun.

Acknowledgements

Acknowledgements: The authors wish to sincerely thank Yevgen Ryeznik for help with the $T_{550\,\mathrm{m}}$ centile tool. In particular, the children and their parents are thanked for their participation. *Financial support:* This work was funded by AUT University with the support of Sport Waikato, Counties Manukau Sport, Sport Northland and the Northland District Health Board and Waikato District Health Board. The funders had no role in the design, analysis or writing of this article. *Conflict of interest:* None. *Authorship:* E.R. and V.O. designed the tool; V.O. and E.R. analysed the data; and E.R., V.O., M.H., R.C. and S.M. wrote the paper. ER had primary responsibility for final content. All authors read and approved the final manuscript. *Ethics of human subject participation:* Ethical approval was not required.

Elaine Rush[1], Stephanie McLennan[2], Victor Obolonkin[1], Rebecca Cooper[1] and Mike Hamlin[3]

[1]Centre for Child Health, Faculty of Health and Environmental Sciences
Auckland University of Technology
Private Bag 92006, Auckland 1142, New Zealand
Email: elaine.rush@aut.ac.nz

[2]Sport Waikato
Hamilton, New Zealand

[3]Department of Social Science, Parks, Recreation Tourism and Sport
Lincoln University
Christchurch, New Zealand

References

1. Brennan LK, Brownson RC & Orleans CT (2014) Childhood obesity policy research and practice: evidence for policy and environmental strategies. *Am J Prev Med* **46**, e1–e16.
2. Kessler R & Glasgow RE (2011) A proposal to speed translation of healthcare research into practice: dramatic change is needed. *Am J Prev Med* **40**, 637–644.

https://doi.org/10.1017/S1368980014003322

3. Rush E, Reed P, McLennan S *et al*. (2012) A school-based obesity control programme: Project Energize. Two-year outcomes. *Br J Nutr* **107**, 581–587.
4. Rush E, McLennan S, Obolonkin V *et al*. (2014) Project Energize: whole-region primary school nutrition and physical activity programme; evaluation of body size and fitness 5 years after the randomised controlled trial. *Br J Nutr* **111**, 363–371.
5. Hamlin MJ, Fraser M, Lizamore CA *et al*. (2014) Measurement of cardiorespiratory fitness in children from two commonly used field tests after accounting for body fatness and maturity. *J Hum Kinet* **40**, 83–92.
6. Benson AC, Torode ME & Singh MA (2006) Muscular strength and cardiorespiratory fitness is associated with higher insulin sensitivity in children and adolescents. *Int J Pediatr Obes* **1**, 222–231.
7. Steene-Johannessen J, Anderssen SA, Kolle E *et al*. (2009) Low muscle fitness is associated with metabolic risk in youth. *Med Sci Sports Exerc* **41**, 1361–1367.
8. Varni JW, Burwinkle TM & Lane MM (2005) Health-related quality of life measurement in pediatric clinical practice: an appraisal and precept for future research and application. *Health Qual Life Outcomes* **3**, 34.
9. Cotten DJ & Singh A (1969) An evaluation of the administration of the 600-yard run–walk on three testing areas. *Res Q* **40**, 226–227.
10. Askew NR (1966) Reliability of the 600-yard run–walk test at the secondary school level. *Res Q* **37**, 451–454.
11. Cooper R (2013) Waist to height ratio in relation to time to run 550 m in primary school children in the Waikato region. MPhil Thesis, AUT University; available at http://aut.researchgateway.ac.nz/handle/10292/5758
12. Cole TJ & Green PJ (1992) Smoothing reference centile curves: the LMS method and penalized likelihood. *Stat Med* **11**, 1305–1319.
13. Rush E & Obolonkin V (2014) Waikato 2011 centile charts for assessment of time to run 550 m [Microsoft Excel workbook]. http://aut.researchgateway.ac.nz/handle/10292/8235 (accessed December 2014).
14. Langford R, Bonell CP, Jones HE *et al*. (2014) The WHO Health Promoting School framework for improving the health and well-being of students and their academic achievement. *Cochrane Database Syst Rev* **4**, CD008958.
15. Galea S & Tracy M (2007) Participation rates in epidemiologic studies. *Ann Epidemiol* **17**, 643–653.

https://doi.org/10.1017/S1368980014003322