Invited Commentary

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

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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 (\(T_{550m}\)) was measured as an indicator of fitness. The \(T_{550m}\) 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 x 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, \(T_{550m}\) 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 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...
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.

Fixed centile curves showing the 3rd, 15th, 50th, 85th and 97th centiles (Fig. 1) for T550 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 T550 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 T550 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, T550 m was measured for 2205/2446 (90%) and in cluster 2, for 1152/1742 (66%) of the school roll. The median T550 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. Centile curves for the T550 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

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**Fig. 1** Baseline measures of median time to run 550 m (T550 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
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 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.

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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**


