11-13-2018

Response to criticisms of the 20-m shuttle run test — deflections, distortions, and distractions

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Title

Response to criticisms of the 20-m shuttle run test — deflections, distortions, and distractions

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Keywords: cardiorespiratory fitness; children; 20-m shuttle run; population health.

Word count: 826

In their editorial, Armstrong and Welsman (1) suggest that the 20-m shuttle run test (20mSRT) (mis)represents and (mis)interprets youth cardiorespiratory fitness (CRF), and potentially (mis)informs health promotion and clinical practice. Their main arguments are: (a) the 20mSRT only provides an estimate of CRF (i.e., peak $\dot{V}O_2$), and (b) estimates are ratio-scaled (i.e., expressed relative to body mass). In this response we provide several reasons, rooted in evidence, which refute their interpretation of our work.

CRF measures the body's capacity to deliver and utilise oxygen for energy transfer to support muscle activity during physical activity (2). The 20mSRT provides a simple, single measure that assesses the integrated responses of the physiological systems' ability to perform progressive aerobic exercise. Unfortunately, it does not provide specific information on the function or contribution of specific systems that can be obtained from a gas analysed peak $\dot{V}O_2$ test. The 20mSRT is a good measure of functional exercise capacity that authentically imitates youth physical activities (e.g., running, agility) in a natural setting. At the individual level, the 20mSRT is a true indicator of peak $\dot{V}O_2$ (absolute or relative to body mass) because peak $\dot{V}O_2$ is achieved at the end of a maximal performance (3). While it is widely accepted that gas-analysed peak $\dot{V}O_2$ is the criterion physiological measure of CRF, other factors also contribute to CRF (e.g., mechanical efficiency, $\dot{V}O_2$ kinetics etc.). 20mSRT performance, as well as treadmill running/walking, is also affected by physical (e.g., excess adiposity) and psychosocial (e.g., self-efficacy, motivation) factors.

Evidence supports the use of the 20mSRT in childhood and adolescence as a powerful marker of current health status (4), independent of adiposity (5), and a predictor of future health (4), making it very useful for population health research. Analogously, BMI is a widely used population health measure with moderate criterion validity and is more strongly associated with health and mortality than criterion-measured adiposity (e.g., hydrostatic weighing) (6). Like BMI, the 20mSRT could be a useful population health measure to identify at-risk populations (4).

Unlike gas-analysed peak $\dot{V}O_2$, the 20mSRT has strong utility and scalability for population health surveillance (4). A recent systematic review of field-based CRF tests identified the 20mSRT as the most scalable for school-based testing (7). It is routinely used as a preferred option to monitor progress in response to physical activity programs because of the low cost of equipment, and its ability to test large groups of participants, simultaneously. For these reasons, the 20mSRT is scalable for international research, especially for data collection in low-income countries.

Armstrong and Welsman (1) highlighted that an earlier study (2) reported a very small trend in the gas-analysed peak $\dot{V}O_2$ (mL/kg/min) of ~4000 youth from five countries between 1962 and 1994. Differences in testing modality/protocols/conditions, metabolic systems, and maximum effort criteria affect the interpretation of such trends. Although now out-dated, the reported trend probably reflects no meaningful change in peak $\dot{V}O_2$ in a non-representative sample of volunteers who likely had an athletic predisposition (2). In contrast, our data of ~1 million youth from 19 countries, which likely provide a better representation of population trends in CRF, indicate a decline in 20mSRT performance between 1981 and 2014, with no recent change in several countries (4). Available data also indicate that declines in 20mSRT performance are independent of changes in adiposity, suggesting corresponding declines in habitual physical activity levels (8).

A meta-analysis reported the 20mSRT's criterion validity as moderate for estimating peak $\dot{V}O_2$ in youth (9), which compares favourably to other field-based CRF tests (e.g., distance/timed runs). We agree with Armstrong and Welsman (1) that allometric scaling can help correct the limitations of traditional ratio-scaled peak $\dot{V}O_2$ which fails to produce peak $\dot{V}O_2$ independent of body mass. Unfortunately, even they have reported body mass exponents ranging from 0.37 to 0.94, highlighting that allometric exponents are sample-specific (10). The continued use of ratio-scaled peak $\dot{V}O_2$ is (in their words) "in the absence of a universally applicable alternative" (10). Despite this, we have recommended reporting 20mSRT results in the measured units (e.g., number of laps, stages, peak running speed), in addition to estimated peak $\dot{V}O_2$, when necessary, with a caveat that the latter results in prediction error. Often at the request of reviewers/editors, we have estimated peak $\dot{V}O_2$ when pooling 20mSRT data to report international norms, trends, and health-related criterion-referenced standards. Regardless, when comparing the CRF of youth in weight-bearing activities and for better transfer to activities of daily living, expressing peak $\dot{V}O_2$ per unit body mass is appropriate.

Armstrong and Welsman (1) suggest that we have (mis)represented and (mis)interpreted youth CRF while potentially (mis)informing health promotion and clinical practice. We strongly disagree. Lab-based peak $\dot{V}O_2$ is an excellent prognostic measure at the individual level. In contrast, the 20mSRT has good feasibility, utility, and scalability for population health surveillance to monitor trends, and inform policymaking and public health planning. Despite their deflections, distortions, and distractions, the 20mSRT is pragmatic, easily understood and routinely used internationally to measure CRF, and we hope this continues.

Acknowledgements

None

Contributors

GRT and JLL drafted the editorial. All authors reviewed and approved the final version.

Competing interests

None declared

Funding information

None

Disclaimer

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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