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DISCUSSION

# Reply to Discussion of "Establishing modified Canadian Aerobic Fitness Test (mCAFT) cut-points to detect clustered cardiometabolic risk among Canadian children and youth aged 9 to 17 years" – The need for foundational fitness research in Canada: is there room for innovation?

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In their editorial, Tremblay and Tomkinson (2020) provided a critical reflection on the modified Canadian Aerobic Fitness Test (mCAFT) and its use in Canadian children and youth. They highlighted that (*i*) the validity and reliability evidence for the test is outdated in adults and nonexistent in children and youth aged <15 years; (*ii*) the background validation evidence for the test and prediction equation to estimate peak oxygen consumption ($\dot{V}O_{2peak}$) is often cited incorrectly in the literature; (*iii*) the Canadian Health Measures Survey (CHMS) exclusion criteria for the mCAFT were very strict and may bias the results; (*iv*) the mCAFT may not properly control for body weight when estimating $\dot{V}O_{2peak}$; and (*v*) using the mCAFT in research on temporal trends and international comparisons in cardiorespiratory fitness is difficult (Tremblay and Tomkinson 2020). While many of the issues raised have merit, we hope to clarify our position for publishing our mCAFT cut-points in Canadian children and youth (Lang et al. 2020). We also want to take this opportunity to highlight the expanding debate in the cardiorespiratory fitness literature which points toward a clear need for innovation and change.

In our paper published in this issue (Lang et al. 2020) we established mCAFT cut-points to identify Canadian children and youth at increased risk of poor cardiometabolic health. We used established statistical methods in a large nationally representative sample of Canadians and obtained cut-point values that are considered high (males: 49–46 mL·kg$^{-1}$·min$^{-1}$; females 46–37 mL·kg$^{-1}$·min$^{-1}$) in comparison with previously identified international cut-points obtained using different field-based tests of cardiorespiratory fitness (males: ~42 mL·kg$^{-1}$·min$^{-1}$; females: ~35 mL·kg$^{-1}$·min$^{-1}$; Ruiz et al. 2016). These results were of concern to us. Furthermore, the mean mCAFT values obtained from the examined CHMS sample were substantially higher than values observed from the pooling of over one million 20-m shuttle-run test scores (Tomkinson et al. 2017). Upon further investigation our conclusions were similar to what Tremblay and Tomkinson concluded: the high mCAFT cut-points may have resulted from the exclusion criteria and/or the validity of the test.

Although strict exclusion criteria holds merit, we were less concerned about this scenario given the fact that previous research involving the CHMS identified only small differences in body mass index between those included (23.2 kg·m$^{-2}$) and excluded (24.1 kg·m$^{-2}$) from the mCAFT (Tremblay et al. 2010). Slightly more problematic was the unresolved validity of the mCAFT in children aged <15 years. However, the importance of construct validity (i.e., the ability of the test to provide an accurate representation of what it purports to measure, in this case, $\dot{V}O_{2peak}$ in mL·kg$^{-1}$·min$^{-1}$) is relative to the objective of the research. For instance, it is very important to have strong construct validity (i.e., the ability to accurately predict $\dot{V}O_{2peak}$) when comparing results with other tests and across different populations. Although not ideal, we were unable to find evidence in the literature that describes the predictive ability for the mCAFT in children and youth, which is likely the root cause of our high mCAFT cut-points. To mitigate this limitation, we made a conscious effort throughout the paper to indicate that our mCAFT cut-points should only be used on those who meet the CHMS inclusion criteria and use the exact same mCAFT protocol and prediction equation. Using the CHMS mCAFT results with lower international cut-points (i.e., 42 and 35 mL·kg$^{-1}$·min$^{-1}$ for males and females, respectively) derived from different submaximal test protocols would lead to substantially higher proportions of Canadian children and youth classified as fit/healthy, leading to possible misclassification and challenges for surveillance and public health messaging. For this reason, the mCAFT cut-points were important to establish for ongoing Canadian fitness surveillance.

Over the past 25 years, cardiorespiratory fitness research has been plagued by debate around test validity that often stems from differing views between lab-based and public/population health researchers (Rowland 1995; Welsman 2019). Lab-based researchers are perhaps more interested in understanding the mechanistic

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progression of directly measured oxygen consumption throughout childhood and into adolescence. They are more likely to focus on learning how to optimize $\dot{V}O_{2peak}$ in athletes and other special sub-groups who are willing to complete a maximal exercise test with directly measured oxygen consumption in a lab-based setting. Population health researchers are interested in the associations between cardiorespiratory fitness and health for surveillance and public health research. Population health research requires large samples to ensure representativeness and precision of estimates precluding direct measures of oxygen consumption owing to issues with feasibility, resources, and the increased burden on participants. Field-based measures, such as the submaximal mCAFT, provide a feasible opportunity to assess cardiorespiratory fitness in settings outside of an exercise laboratory (e.g., schools, clinics). Compounding the issue with validity is the fact that there are dozens of maximal and submaximal field-based tests for cardiorespiratory fitness, including distance and timed runs, walking tests, step tests, and shuttle-run tests, all of which have a variety of protocols and prediction equations to estimate $\dot{V}O_{2peak}$ values. This chaotic situation is perhaps the single reason why predicting $\dot{V}O_{2peak}$ when using field-based tests is very common — it is an attempt, albeit with limitations, to compare apples to apples (i.e., shuttle-run test results to step test results). With these efforts come a host of issues with validity and prediction error that population health researchers have come to accept as "our best effort to interpret the available data", with these decisions being further reinforced by strong associations with health despite the potential for prediction error (Lang et al. 2019).

The field of cardiorespiratory fitness measurement is ripe and ready for innovation and change from the status quo (i.e., $\dot{V}O_{2peak}$ in $mL{\cdot}kg^{-1}{\cdot}min^{-1}$). Possibilities include (*i*) the international selection of 2 or 3 core field-based tests, which can be delivered in a variety of settings; (*ii*) a move away from predicted values to raw values (e.g., peak running speed); (*iii*) establishing international repositories of test data to improve comparability both internationally and over time (i.e., temporal trends), which is similar to efforts currently underway in physical activity research (Sherar et al 2011); and (*iv*) the identification of standard health-related cut-points for cardiorespiratory fitness. These opportunities have clear implications for the mCAFT, as we whole-heartedly believe and agree with others that more work is needed to better calibrate the test. Until that time, we believe that our mCAFT cut-points can help inform surveillance, but they should not be used for comparison with other tests or outside of the Canadian context.

### 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.

### Conflict of interest statement

The authors report that there are no conflicts of interest.

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