Objective: To evaluate the construct validity and responsiveness of the Rapid Assessment of Physical Activity (RAPA) for measuring physical activity (PA) in adults living with HIV.

Design: Secondary analysis of an interrupted time-series intervention study.

Setting: Community-based fitness facility in Toronto, Canada.

Participants: Sixty-seven adults (N=67) living with HIV (n=5 women; mean age, 51.8 ± 11.6 years) with available baseline data to assess for construct validity of the RAPA, of which 50 (n=4 women; age, 53.2 ± 11.4 years) had follow-up data to evaluate responsiveness.
Interventions: Two months of a community-based exercise intervention involving thrice weekly multicomponent exercises.

Main Outcome Measures: We used a single-item PA questionnaire as a convergent outcome to the RAPA, while peak oxygen consumption, general health status, and number of concurrent health conditions were divergent outcomes. We tested 11 a priori hypotheses (6 construct validity, 5 responsiveness) using Spearman $\rho$, Wilcoxon signed-rank tests, Cohen’s $d$, standardized effect size (SES), and standardized response mean (SRM). We considered acceptable construct validity and responsiveness if $>75\%$ of hypotheses were confirmed.

Results: All of the hypotheses (100%) for construct validity were confirmed. The RAPA demonstrated moderate correlations with the single-item PA questionnaire ($\rho=0.61$), and negligible correlations with divergent outcome measures ($\rho=0.08-0.21$). Two of the 5 hypotheses (40.0%) for responsiveness were confirmed. RAPA scores were significantly greater after 2 months of training ($P<.001$) and demonstrated a small to moderate effect size ($d=0.50$, SES=0.47, SRM=0.48). There was a low correlation between change in RAPA scores and change in single-item PA questionnaire scores ($\rho=0.48$).

Conclusions: The RAPA demonstrated acceptable construct validity and poor responsiveness in adults living with HIV. Therefore, the RAPA can be used cross-sectionally but may be used in conjunction with other measures of PA for adults living with HIV.

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Nearly 40 million adults live with HIV worldwide, which has a high per person cost in the United States for prevention and treatment. Medical advancements including antiretroviral therapy have increased the lifespan of adults living with HIV, but with longevity, this population has an increased risk for developing and accumulating chronic conditions such as cardiovascular, liver, and renal disease. In fact, the proportion of adults living with HIV and multimorbidity is more than 2-fold that of the general population. Preventing and minimizing the effects of multimorbidity among adults living with HIV has become a priority for HIV rehabilitation.

Physical activity (PA) is a safe and effective strategy for managing the development of accumulating chronic conditions in this population. Adults living with HIV who participate in PA demonstrate greater cardiorespiratory fitness, neurocognitive functioning, and functional independence. However, HIV is described as episodic in nature, which is characterized by fluctuating levels of symptoms and impairments, social inclusion, difficulties with day-to-day activities, and uncertainty. Thus, fluctuations in disease course may present barriers to regular participation in PA, making it unsurprising that only half of adults living with HIV meet PA recommendations.

Assessments of PA that can capture the episodic course of disease are therefore critical for rehabilitation in adults living with HIV. Although objective measures (eg, accelerometry or wearable activity monitors) can provide detailed data on PA, they are often time and resource intensive for both clinicians and participants when measured over multiple days. Additionally, adherence to wearable monitors has shown to decline over time and also fluctuate substantially with age and PA level. The use of such measures is important but may be impractical or become deprioritized for adults living with HIV because of competing health priorities such as adequate sleep, management of medications, and depression. Rapid self-reported PA assessments such as self-reported questionnaires may be a more feasible alternative; thus, their validation is critical.

The Rapid Assessment of Physical Activity (RAPA) is a 9-item questionnaire developed to measure the amount, type, and intensity of habitual PA participation among older adults. The questionnaire has demonstrated construct validity in middle-aged and older adults but has not yet been assessed in adults living with HIV. Considering the episodic disability that occurs in adults living with HIV, it is also important to understand the RAPA’s ability to detect fluctuations in PA over time (ie, responsiveness). Thus, the objective of this study was to evaluate the construct validity and responsiveness of the RAPA in adults living with HIV.

Methods

Study design

We conducted a secondary analysis of an interrupted time-series study examining the effects of a community-based exercise (CBE) intervention on indices of disability and health in adults living with HIV (Trial Registration No.: NCT02794415). In brief, the original study was 22 months in duration and consisted of bimonthly assessments over 3 phases: (1) baseline monitoring (months 0-8), (2) a CBE intervention (months 8-14), and (3) postintervention follow-up (months 14-22). For the purpose of this analysis, preintervention was considered the last time point of the monitoring phase before the CBE intervention commenced (ie, month 8), and post intervention was considered the early phase of the CBE intervention (ie, month 10). This was done to maximize the available sample size and probability of real change in PA levels. To address our primary objective (construct validity), we used data from preintervention. For our secondary objective (responsiveness), we examined...
changes in our measures from pre- to post intervention. This research was approved by the HIV/AIDS Research Ethics Board at the University of Toronto (Protocol #32910) and McMaster University (HiREB Project ID #12834).

Participants

Community-dwelling adults living with HIV (18 years or older) were eligible for the CBE study24 if they considered themselves medically stable to perform exercise as determined by the Physical Activity Readiness Questionnaire.27 Participants provided informed consent for the original trial25 and were eligible for the present analysis if they had available data on (1) the RAPA at pre- (primary objective, construct validity) and post intervention (secondary objective, responsiveness), (2) the single-item PA questionnaire,28 (3) cardiorespiratory fitness, (4) general health status, and (5) total number of concurrent health conditions.

Community-based intervention

The details of the CBE intervention have been published elsewhere.24 In brief, the intended exercise intervention involved a combination of aerobic, resistance, neuromotor, and stretching exercises for 90 minutes, 3 times per week. Aerobic exercise was performed at 60%-70% of maximal heart rate, and resistance exercise was performed using 8-10 exercises for all major muscle groups, at 60%-70% 1-repetition maximum for 10-12 repetitions. One of the 3 sessions each week was supervised by a fitness instructor who adjusted exercise intensities and monitored attendance and progress.

Rapid Assessment of Physical Activity

The RAPA was our main measure of interest. The RAPA is a 9-item questionnaire, originally developed to assess the quantity and intensity of PA participation in adults 50 years or older.20 Participants are asked about the frequency, intensity and duration of their PA behavior (eg, “I do moderate physical activities every week but less than 30 minutes a day or 5 days a week.” [Yes/No]). The RAPA is composed of 2 components. The RAPA-1 uses 7 questions to assess participation in aerobic activities; responses are scored on an ordinal scale ranging from 1 (sedentary) to 7 (active).20 Any number <6 is considered suboptimal. The RAPA-2 assesses participation in strength and/or flexibility activities on a 4-point nominal scale, where 0 represents no participation in either activity, 1 represents participation in strength activities, 2 represents participation in flexibility, and 3 represents participation in both. Because the RAPA-2 is scored on a nominal scale, we did not assess the construct validity or responsiveness of this component. Henceforth, we will refer to RAPA as the 7-item aerobic component.

Convergent and divergent outcomes

The comparison outcome measures for our construct validity analysis were selected based on a conceptual framework of PA.29 The framework categorizes PA behavior into 3 domains: disability, functional status, and health and fitness.20,29 Each domain consists of 2 or more constructs related to PA. The RAPA represents the construct of PA under the domain of health and fitness. For construct validity analyses, we selected outcomes that were classified on a continuum of constructs similar or dissimilar to PA according to the conceptual framework.29,30 All measures were assessed at the same study time points (ie, preintervention, month 8).

Single-item PA questionnaire

We used a single-item PA questionnaire as a reference measure of self-reported PA participation, which has been validated in the general population.28 The question, “In the past week, on how many days have you done a total of 30 minutes or more of PA, which was enough to raise your breathing rate? This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places but should not include housework or PA that may be part of your job.” was scored on an ordinal scale ranging from 1 (no days of ≥30 minutes) to 8 (7 days of ≥30 minutes, each day).

Cardiorespiratory fitness

Cardiorespiratory fitness (maximum oxygen consumption, mL/kg/min) was measured using indirect calorimetry on a metabolic cart following a progressive incremental protocol on a cycle ergometer. The tests began at 50 W, increasing intensity at a rate of 25 W/min until the end of the test. Tests were terminated according to the American College of Sports Medicine criteria and were administered by trained staff. According to the conceptual framework,29 cardiorespiratory fitness is categorized in the same domain as the RAPA (ie, health and fitness) but represents a different construct. Hence, we considered cardiorespiratory fitness a divergent comparison measure to the RAPA.

General health status

General health status is categorized in the disability domain of the conceptual framework and is the most distal construct to PA.29 Therefore, we selected this measure to demonstrate divergent validity with the RAPA. General health status was measured using the question from the 36-Item Short Form Survey that asked: “In general, would you say your health is (1) Excellent, (2) Very good, (3) Good, (4) Fair, or (5) Poor?”

Total number of concurrent health conditions

Total number of concurrent health conditions was determined by a self-reported demographic questionnaire that asked participants’ history of currently living with chronic comorbid conditions in addition to HIV. Participants were also provided an option to identify “Other” condition(s) that were not listed. The total number of concurrent health conditions was the sum of conditions from which participants responded “Yes.” Total number of comorbidities represents a different domain and construct to RAPA and was
considered another divergent comparison measure for our analysis.

**Statistical analyses**

Baseline participant characteristics were described using means and standard deviations (SDs) for normally distributed continuous data. Medians and interquartile ranges (IQRs) were used for continuous data with a nonnormal distribution and for ordinal variables. Frequencies and percentages were used to describe categorical data.

The criterion standard for measuring energy expenditure and PA, such as doubly labeled water\textsuperscript{35} and accelerometry, were not collected in this study; thus, we used a construct approach\textsuperscript{26} to verify 11 a priori hypotheses on construct validity (6) and responsiveness (5) of the RAPA (table 1). We considered acceptable construct validity and responsiveness if $>75\%$ ($\geq 5$ construct validity, $\geq 4$ responsiveness) hypotheses were confirmed.\textsuperscript{36} All statistical analyses were performed on Stata/IC (Version 16.1, College Station, TX, USA).\textsuperscript{c}

**Construct validity (hypotheses 1-6)**

We assessed construct validity by testing a series of a priori hypothesized theoretical relationships between the RAPA and the comparison measures. We conducted a Spearman

| Table 1  | Baseline participant characteristics (N=67 participants) |
|----------|----------------------------------------------------------|
| Variable                          | n          | Total, N=67 | Men, N=62 | Women, N=5 |
| Age (y), mean ± SD                 | 67         | 51.3±11.5   | 52.4±11.5 | 44.4±10.5  |
| Time since HIV diagnosis (y), median (IQR) | 66         | 24.6 (10.3) | 28 (19)   | 13 (9)     |
| Undetectable viral load (<50 copies/mL), n (%) | 59         | 57 (85)     | 54 (87)   | 3 (60)     |
| Gross annual income (CAD), n (%)   | 67         |             |           |            |
| $<$10,000                          | 9          | 8 (13)      | 1 (20)    |
| $10,000-$19,000                    | 23         | 21 (34)     | 2 (40)    |
| $20,000-$29,000                    | 5          | 4 (7)       | 1 (20)    |
| $30,000-$39,000                    | 6          | 6 (10)      | 0 (0)     |
| $40,000-$49,000                    | 8          | 8 (13)      | 0 (0)     |
| $50,000-$59,000                    | 6          | 6 (10)      | 0 (0)     |
| $>60,000                           | 8          | 8 (13)      | 0 (0)     |
| Education, n (%)                   |            |             |           |            |
| Less than high school              | 7          | 6 (10)      | 1 (20)    |
| Completed high school              | 6          | 5 (8)       | 1 (20)    |
| Some college or university         | 11         | 10 (16)     | 1 (20)    |
| Completed college or university    | 28         | 27 (44)     | 1 (20)    |
| Postgraduate education             | 14         | 13 (21)     | 1 (20)    |
| Ethnicity, n (%)                   |            |             |           |            |
| Indigenous                         | 4          | 4 (6)       | 0 (0)     |
| White                              | 44         | 42 (68)     | 2 (40)    |
| Asian                              | 11         | 10 (16)     | 1 (20)    |
| Black                              | 4          | 2 (3)       | 2 (40)    |
| Hispanic                           | 4          | 4 (6)       | 0 (0)     |
| Other                              | 6          | 5 (8)       | 1 (20)    |
| Concurrent health conditions, n (%)|            |             |           |            |
| Bone and/or joint disorder         | 27         | 25 (40)     | 2 (40)    |
| Cardiovascular disease             | 6          | 6 (10)      | 0 (0)     |
| Chronic obstructive pulmonary disease | 7          | 7 (11)     | 0 (0)     |
| Diabetes                           | 8          | 8 (13)      | 0 (0)     |
| Hypertension                       | 14         | 13 (21)     | 1 (20)    |
| Obesity                            | 9          | 7 (11)      | 2 (40)    |
| No. of concurrent health conditions, median (IQR) | 67         | 4 (5)       | 5 (5)     | 2 (4)     |
| Self-reported general health status, mean ± SD | 67         | 2.7±0.8     | 3±1       | 2±1       |
| VO$_{2}$peak (mL/kg/min), mean ± SD | 67         | 24.3±8.1    | 24.9±8.0  | 17.3±5.4  |
| RAPA aerobic component, median (IQR) | 67         | 6 (3)       | 6 (3)     | 7 (3)     |
| RAPA strength/flexibility component, n (%) | 67         |             |           |            |
| Neither strength nor flexibility exercise | 19         | 19 (29.2)   | 0 (0)     |
| Participate in strength exercise    | 5          | 5 (7.7)     | 0 (0)     |
| Participate in flexibility exercise | 14         | 12 (18.5)   | 2 (40)    |
| Participate in both                 | 29         | 26 (40.0)   | 3 (60)    |
| Single-item PA questionnaire, median (IQR) | 67         | 4 (3)       | 4 (3)     |

Abbreviations: CAD, Canadian dollar; VO$_{2}$peak, peak oxygen consumption.
correlation analyses ($\rho$) between the RAPA and (1) single-item PA questionnaire, (2) cardiorespiratory fitness, (3) general health status, and (4) total number of concurrent health conditions.

**Responsiveness analyses (hypotheses 7-11)**
We used a combination of distribution and correlational methods to assess responsiveness. The most frequent approach to distribution-based methods of assessing responsiveness is to evaluate the change in a given measure before and after an intervention that is known to create change and when change has occurred in at least a portion of the sample. We used a comprehensive approach of a Wilcoxon signed-rank test and several effect size calculations. We chose to use 3 effect size measures because there is no consensus on the appropriate effect size statistic. The formulas for each estimate are presented below:

Cohen’s $d = \frac{D_x}{SD(X_{\text{pooled}})}$

Standardized effect size $= \frac{D_x}{SD(X_{\text{baseline}})}$

Standardized response mean $= \frac{D_x}{SD(D_x)}$

Correlational methods represent the extent to which changes in a measure of interest relate to changes in a reference measure. We used a correlational method (Spearman correlation) between the change in RAPA scores and change in the single-item PA questionnaire scores (reference measure). Similar to construct validity, we used a construct approach for both distribution and correlational methods to our responsiveness analyses.

**Results**
Figure 1 depicts the flow of participants through the study. Data were extracted from 120 participants enrolled in the original trial, of which 67 (62 men, 5 women) were included in the construct validity analysis. A subset of 50 participants (46 men, 4 women) with follow-up data were included in the responsiveness analysis.

Baseline participant characteristics are presented in Table 1, disaggregated by sex identity. No formal tests of hypotheses were conducted between sex identities because of the small proportion of women in this analysis. However, women had generally lower cardiorespiratory fitness, more recent HIV diagnosis, and fewer concurrent health conditions.

**Construct validity**
The a priori hypotheses and results of the construct validity analysis preintervention are presented in Table 2. All of the 6 hypotheses (6/6, 100%) for construct validity were confirmed. The RAPA scores demonstrated a moderate positive correlation with the single-item PA questionnaire scores.
and negligible correlations $r=-0.04$ to $0.21$) with divergent outcomes. The complete correlation matrix with 95% CIs is presented in supplemental appendix S1 (available online only at http://www.archives-pmr.org/).

### Table 2 Construct validity assessment of the Rapid Assessment of Physical Activity: correlation analysis hypothesis testing (N=67 participants)

| Hypotheses | Result | Confirmed |
| --- | --- | --- |
| The correlation between RAPA scores and the single-item physical activity questionnaire scores will be as follows: | | |
| 1 Greater than the correlation between the RAPA scores and cardiorespiratory fitness by $>0.1$ | 0.61 vs 0.21 | Yes |
| 2 Greater than the correlation between the RAPA scores and general health status score by $>0.2$ | 0.61 vs 0.08 | Yes |
| 3 Greater than the correlation between the RAPA scores and the total number of concurrent health conditions by $>0.2$ | 0.61 vs $-0.04$ | Yes |
| The correlation between the RAPA scores and cardiorespiratory fitness will be as follows: | | |
| 4 Greater than the correlation between the RAPA scores and general health status by $>0.1$ | 0.21 vs 0.08 | Yes |
| 5 Greater than the correlation between the RAPA scores and the total number of comorbidities by $>0.1$ | 0.21 vs $-0.04$ | Yes |
| The correlation between the RAPA scores and general health status scores will be as follows: | | |
| 6 Greater than the correlation between the RAPA scores and the total number of concurrent health conditions by $>0.1$ | 0.08 vs $-0.04$ | Yes |
| Percentage of hypotheses confirmed: | 100% |

| Hypotheses | Result | Confirmed |
| --- | --- | --- |
| The RAPA will significantly increase from baseline to follow-up ($P<.05$) | $P<0.0001$ | Yes |
| The RAPA will demonstrate a moderate effect size (Cohen’s $d \geq 0.5$) | $d=0.50$ | Yes |
| The RAPA will demonstrate a moderate effect size (SES $\geq 0.5$) | SES=0.47 | No |
| The RAPA will demonstrate a moderate effect size (SRM $\geq 0.5$) | SRM=0.48 | No |
| There will be a moderate positive correlation between the change in RAPA scores and change in the single-item physical activity questionnaire scores ($\rho \geq 0.50$) | $0.48$ | No |
| Percentage of hypotheses confirmed: | 40.0% |

### Table 3 Internal and external responsiveness of the RAPA (n=50 participants)

### Discussion

This was the first study to assess the construct validity and responsiveness of the RAPA in adults living with HIV. We demonstrated 2 important findings. First, the RAPA demonstrated acceptable construct validity because 100% of the a priori hypotheses were confirmed. Second, the RAPA had poor responsiveness because only 40% of hypotheses were confirmed.

We applied a conceptual framework for selecting convergent and divergent measures in our analyses, which allowed us to develop a robust impression of the RAPA’s construct validity. As expected, we observed a gradient of correlations, wherein scores of measures more closely related to the construct of PA were more highly correlated with RAPA scores. For instance, the RAPA was moderately correlated with the single-item PA questionnaire but demonstrated negligible correlations with the divergent measures (eg, general health status, total number of concurrent health conditions). The magnitude of correlations between

### Responsiveness

The a priori hypotheses and results for responsiveness are presented in table 3. Overall, 2 of the 5 hypotheses (40.0%) for responsiveness were confirmed. RAPA scores were greater than baseline after 2 months of exercise training (baseline: 6 [IQR, 3], post intervention: 7 [IQR, 1], $P<.001$), and demonstrated a small to moderate effect size ($d=0.50$, standardized effect size [SES]=0.47, SRM=0.48). There was a low positive correlation between the change in RAPA and change in the single-item PA questionnaire ($\rho=0.48$).
RAPA and our reference measure of PA are aligned with previous reports in adults living with HIV\textsuperscript{31} and the general population.\textsuperscript{22} Dagenais et al reported moderate correlations between RAPA scores and a wearable PA monitor,\textsuperscript{31} which were similar to our findings. Likewise, Vega-López et al found moderate correlations between RAPA scores and accelerometry-derived PA in the general population.\textsuperscript{22} However, neither of these studies examined correlations with divergent measures. Our study’s findings reinforce the importance of conceptual frameworks in guiding hypotheses during the assessment of construct validity.

For our responsiveness analyses, the RAPA demonstrated small to moderate effect sizes after 2 months of CBE training. These effects are much greater than what were observed after a 12-week yoga intervention in adults living with HIV\textsuperscript{31} but smaller than a multicomponent exercise intervention in older adults without HIV.\textsuperscript{41} However, distribution-based methods are susceptible to variability in interventions and adherence. The low training specificity of yoga, relative to the constructs measured by the RAPA, are likely to yield smaller effect sizes compared with the multicomponent exercise intervention provided in the current study,\textsuperscript{24} because yoga does not uniquely represent the construct of aerobic exercise. Indeed, the yoga intervention consisted primarily of breathing, meditation, and introspection, which may not have been captured well by the RAPA.\textsuperscript{40} Conversely, while the multicomponent exercise intervention among older adults\textsuperscript{41} was similar to the current study, higher adherence rates (86%-99%) may have yielded larger effects ($d=1.06$). Our sensitivity analyses (not shown) support this hypothesis because we found a very large effect size among those who attended every exercise session ($n=13$, $d=0.96$, $SES=0.97$, $SRM=1.00$) compared with those who attended $\leq 2$ sessions per week ($n=37$, $d=0.36$, $SES=0.33$, $SRM=0.34$).

Because distribution-based methods are influenced by intervention type and adherence, sample size, and heterogeneity,\textsuperscript{26} Consensus-based Standards for the Selection of Health Measurement Instruments recommends not to draw conclusions about the responsiveness of a measure using $P$ values or effect size estimates alone.\textsuperscript{26} Instead, we examined responsiveness using a construct approach, making informed a priori hypotheses about the direction and magnitude of effect sizes and correlations between the change in RAPA scores and the single-item PA questionnaire scores. We anticipated a moderate to high correlation between change scores because they measure the same construct of PA\textsuperscript{29} but found a small to moderate correlation. Increased variability because of repeated measurements and variability in the time between responses (64.2±10.5 days) may help explain the lower-than-expected correlation. Additionally, lower correlations may be because of differences in the measured time frame of the self-reported assessments. For example, the RAPA asks participants about their usual behaviors, while the single-item PA questionnaire asks specifically about the past week. Given the episodic disability in this population, PA levels may vary over a longer time frame, which can create discrepancies between measures with shorter time frames. Yet, we emphasize that neither distribution nor correlational methods alone are the sole basis of our findings and that both are used in our interpretations. Psychometric evaluation is an iterative process; thus, further research using a construct approach is needed in this area.

**Study limitations**

We acknowledge that this study only included self-reported measures of PA. Thus, we were limited by the absence of a criterion measure of PA such as accelerometers. Nonetheless, we used a comprehensive approach in our analysis to establish construct validity of the RAPA by using outcome measures selected from a conceptual framework,\textsuperscript{29} as recommended by Consensus-based Standards for the Selection of Health Measurement Instruments.\textsuperscript{26} We also acknowledge that this was a secondary analysis of a larger intervention study, which prevents the control over our study design. However, the original study consisted of many time points,\textsuperscript{24} enabling the careful selection of time points that are likely to observe change, which is a requisite assumption for responsiveness studies.\textsuperscript{26} Moreover, because the strength and flexibility component is measured on a categorical (nominal) scale, this study was only able to assess the aerobic component of RAPA. Finally, women were underrepresented in our analyses (5/67, 5%), which precludes the generalizability of our findings to both men and women living with HIV. Future studies in different contexts and with a broad range of adults living with HIV are warranted to further evaluate the psychometric properties of the RAPA.

**Conclusions**

With a construct approach, the present study found that the RAPA demonstrated acceptable construct validity but poor responsiveness among a sample of community-dwelling adults living with HIV. It is important that measures of PA used in adults living with HIV are able to detect change when it occurs because of the episodic disability experienced in this population. Therefore, our results indicate that the RAPA is sufficiently valid to use cross-sectionally but should be used in combination with other objective measures of PA to assess change.

**Suppliers**

a. CardioCoach; KORR Medical Technologies, Salt Lake City, UT.

b. Monark model 817; Monark Exercise, Vansbro, Sweden.

c. Stata/IC Version 16.1; StataCorp, College Station, TX.

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