ORIGINAL RESEARCH

Construct Validity and Responsiveness of the Rapid Assessment of Physical Activity in Adults Living With HIV

Check for updates

Kenneth S. Noguchi, MSc [a], Kelly K. O'Brien, PT, PhD [b,c,d],
Rachel L. Aubry, MSc [b], Soo Chan Carusone, PhD [e,f],
Lisa Avery, MSc [g,h], Patricia Solomon, PhD [a], Ivan Ilic, MA [i],
Zoran Pandovski, BA [i], Mehdi Zobeiry, MA [i],
Ada Tang, PT, PhD [a]

[a] *School of Rehabilitation Science, McMaster University, Hamilton, Ontario*
[b] *Department of Physical Therapy, University of Toronto, Toronto, Ontario*
[c] *Rehabilitation Sciences Institute, University of Toronto, Toronto, Ontario*
[d] *Institute of Health Policy, Management, and Evaluation, University of Toronto, Toronto, Ontario*
[e] *Casey House, Toronto, Ontario*
[f] *Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Ontario*
[g] *University Health Network, Toronto, Ontario*
[h] *Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario*
[i] *Toronto Central Grosvenor Street YMCA, Toronto, Ontario, Canada*

Abstract *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 ρ, 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 (ρ=0.61), and negligible correlations with divergent outcome measures (ρ=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 (ρ=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.

Nearly 40 million adults live with HIV worldwide,[1] which has a high per person cost in the United States for prevention and treatment.[2] Medical advancements including antiretroviral therapy have increased the lifespan of adults living with HIV,[3] but with longevity, this population has an increased risk for developing and accumulating chronic conditions such as cardiovascular,[4] liver, and renal disease.[5] In fact, the proportion of adults living with HIV and multimorbidity is more than 2-fold that of the general population.[6] 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.[7] Adults living with HIV who participate in PA demonstrate greater cardiorespiratory fitness,[8,9] neurocognitive functioning,[10,11] and functional independence.[11] 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.[11-14] Thus, fluctuations in disease course may present barriers to regular participation in PA,[14] making it is unsurprising that only half of adults living with HIV meet PA recommendations.[15]

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 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[16] and also fluctuate substantially with age[16] and PA level.[17] The use of such measures is important[18] 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.[19] 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.[20] The questionnaire has demonstrated construct validity in middle-aged[21,22] and older adults[20] but has not yet been assessed in adults living with HIV. Considering the episodic disability that occurs in adults living with HIV,[12,14] it is also important to understand the RAPA's ability to detect fluctuations in PA over time (ie, responsiveness).[23] 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).[24,25] 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.[26] 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 study[24] 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 trial[25] 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.[29,30] 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 $\geq$30 minutes) to 8 (7 days of $\geq$30 minutes, each day). The single-item PA questionnaire has demonstrated a moderate correlation ρ=0.53-0.70) with a wearable PA monitor in adults living with HIV[31] and moderate responsiveness (standardized response mean [SRM]=0.77) in middle-aged adults.[32] We considered the questionnaire a convergent reference measure to the RAPA because it measures the same underlying construct of PA according to the conceptual framework.[29]

Cardiorespiratory fitness
Cardiorespiratory fitness (maximum oxygen consumption, mL/kg/min) was measured using indirect calorimetry on a metabolic cart[a] following a progressive incremental protocol on a cycle ergometer.[b] 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[33] 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[34] 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[35] and accelerometry,

were not collected in this study; thus, we used a construct approach[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% (≥5 construct validity, ≥4 responsiveness) hypotheses were confirmed.[36] All statistical analyses were performed on Stata/IC (Version 16.1, College Station, TX, USA).[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 (%)				
<$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 (%)				
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)	4 (3)

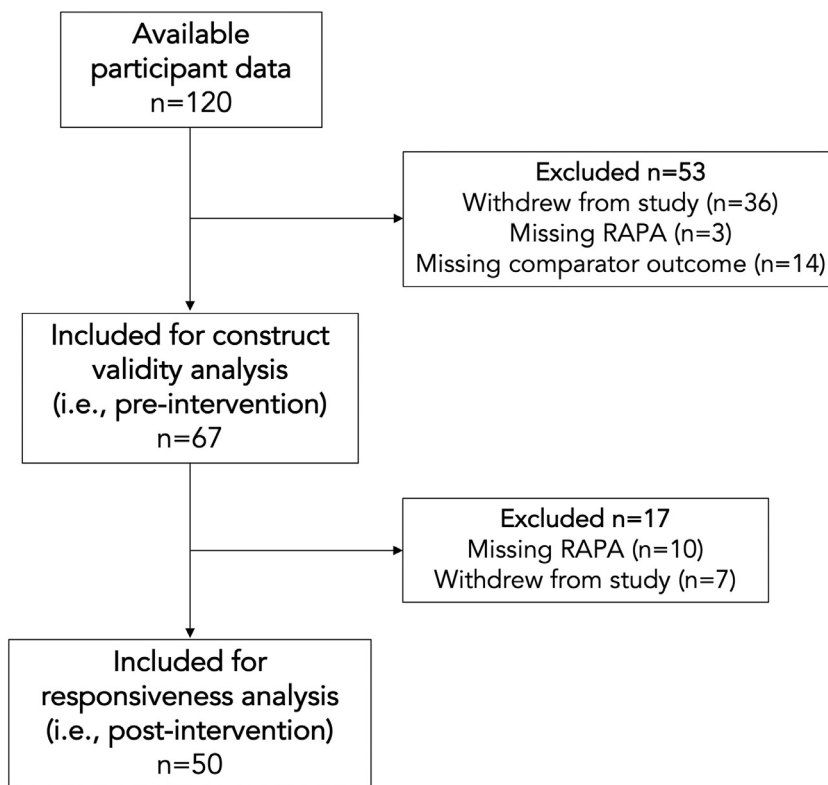Abbreviations: CAD, Canadian dollar; Vo$_2$peak, peak oxygen consumption.

Fig 1 Study flow chart.

correlation analyses (ρ) 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.[37] 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.[37,38] The formulas for each estimate are presented below:

$$Cohen's\ d = \frac{\bar{D}_x}{SD(X_{pooled})}$$

$$Standardized\ effect\ size = \frac{\bar{D}_x}{SD(X_{baseline})}$$

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

Correlational methods represent the extent to which changes in a measure of interest relate to changes in a reference measure.[37,39] 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.[26]

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

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

Hypotheses	Result RAPA vs Other Measure	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%

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

Hypotheses	Result	Confirmed
Distribution-based method:		
1 The RAPA will significantly increase from baseline to follow-up ($P<.05$)	$P<0001$	Yes
2 The RAPA will demonstrate a moderate effect size (Cohen's $d \geq 0.5$)	$d=0.50$	Yes
3 The RAPA will demonstrate a moderate effect size (SES$\geq$0.5)	SES=0.47	No
4 The RAPA will demonstrate a moderate effect size (SRM$\geq$0.5)	SRM=0.48	No
Correlational method:		
5 There will be a moderate positive correlation between the change in RAPA scores and change in the single-item physical activity questionnaire scores (ρ>0.50)	0.48	No
Percentage of hypotheses confirmed:		40.0%

ρ=0.61), and negligible correlations ρ=−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/).

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 ρ=0.48).

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[29] 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

RAPA and our reference measure of PA are aligned with previous reports in adults living with HIV[31] and the general population.[22] Dagenais et al reported moderate correlations between RAPA scores and a wearable PA monitor,[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.[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[40] but smaller than a multicomponent exercise intervention in older adults without HIV.[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[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.[40] Conversely, while the multicomponent exercise intervention among older adults[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 ≤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,[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.[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[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,[29] as recommended by Consensus-based Standards for the Selection of Health Measurement Instruments.[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,[24] enabling the careful selection of time points that are likely to observe change, which is a requisite assumption for responsiveness studies.[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.

Corresponding author

Ada Tang, PT, PhD, McMaster University, 1400 Main St West, Institute for Applied Health Sciences, Room 437, Hamilton, Ontario, Canada L8S 1C7. *E-mail address:* atang@mcmaster.ca.

Acknowledgments

study (Realize, AIDS Committee of Toronto, Casey House, and Toronto PWA Foundation).

References

1. Frank TD, Carter A, Jahagirdar D, et al. Global, regional, and national incidence, prevalence, and mortality of HIV, 1980 −2017, and forecasts to 2030, for 195 countries and territories: a systematic analysis for the Global Burden of Diseases, Injuries, and Risk Factors Study 2017. Lancet HIV 2019;6:e831-59.

2. Gebo KA, Fleishman JA, Conviser R, et al. Contemporary costs of HIV healthcare in the HAART era. AIDS 2010;24:2705-15.

3. Teeraananchai S, Kerr S, Amin J, Ruxrungtham K, Law M. Life expectancy of HIV-positive people after starting combination antiretroviral therapy: a meta-analysis. HIV Med 2017;18:256-66.

4. Triant VA, Lee H, Hadigan C, Grinspoon SK. Increased acute myocardial infarction rates and cardiovascular risk factors among patients with human immunodeficiency virus disease. The J Clin Endocrinol Metab 2007;92:2506-12.

5. Goulet JL, Fultz SL, Rimland D, et al. Do patterns of comorbidity vary by HIV status, age, and HIV severity? Clin Infect Dis 2007;45:1593-601.

6. Guaraldi G, Orlando G, Zona S, et al. Premature age-related comorbidities among HIV-infected persons compared with the general population. Clin Infect Dis 2011;53:1120-6.

7. Jaggers JR, Hand GA. Health benefits of exercise for people living with HIV. Am J Lifestyle Med 2014;10:184-92.

8. Florindo AA, Latorre Mdo R, Santos EC, Negrão CE, Azevedo LF, Segurado AA. Validity and reliability of the Baecke questionnaire for the evaluation of habitual physical activity among people living with HIV/AIDS. Cad Saúde Pública 2006;22:535-41.

9. Jaggers JR, Prasad VK, Dudgeon WD, et al. Associations between physical activity and sedentary time on components of metabolic syndrome among adults with HIV. AIDS Care 2014;26:1387-92.

10. Dufour CA, Marquine MJ, Fazeli PL, et al. A longitudinal analysis of the impact of physical activity on neurocognitive functioning among HIV-infected adults. AIDS Behav 2018;22:1562-72.

11. Fazeli PL, Marquine MJ, Dufour C, et al. Physical activity is associated with better neurocognitive and everyday functioning among older adults with HIV disease. AIDS Behav 2015;19:1470-7.

12. O'Brien KK, Bayoumi AM, Strike C, Young NL, Davis AM. Exploring disability from the perspective of adults living with HIV/AIDS: development of a conceptual framework. Health and Qual Life Outcomes 2008;6:76.

13. O'Brien KK, Davis AM, Strike C, Young NL, Bayoumi AM. Putting episodic disability into context: a qualitative study exploring factors that influence disability experienced by adults living with HIV/AIDS. J Int AIDS Soc 2009;12:30.

14. Solomon P, O'Brien KK, Nixon S, Letts L, Baxter L, Gervais N. Trajectories of episodic disability in people aging with HIV: a longitudinal qualitative study. J Int Assoc Provid AIDS Care 2018;17:232595821875921.

15. Vancampfort D, Mugisha J, De Hert M, et al. Global physical activity levels among people living with HIV: a systematic review and meta-analysis. Disabil Rehabil 2018;40:388-97.

16. Hermsen S, Moons J, Kerkhof P, Wiekens C, De Groot M. Determinants for sustained use of an activity tracker: observational study. JMIR Mhealth Uhealth 2017;5:e164.

17. Yingling LR, Mitchell V, Ayers CR, et al. Adherence with physical activity monitoring wearable devices in a community-based population: observations from the Washington, D.C., Cardiovascular Health and Needs Assessment. Transl Behav Med 2017;7:719-30.

18. Dagenais M, Cheng D, Salbach NM, Brooks D, O'Brien KK. Wireless physical activity monitor use among adults living with HIV: a scoping review. Rehabil Oncol 2019;37:17-28.

19. deBoer H, Andrews M, Cudd S, et al. Where and how does physical therapy fit? Integrating physical therapy into interprofessional HIV care. Disabil Rehabil 2019;41:1768-77.

20. Topolski TD, LoGerfo J, Patrick DL, Williams B, Walwick J, Patrick MB. The Rapid Assessment of Physical Activity (RAPA) among older adults. Prev Chronic Dis 2006;3:A118.

21. Silva AG, Queirós A, Alvarelhão J, Rocha NP. Validity and reliability of the Portuguese version of the Rapid Assessment of Physical Activity questionnaire. Int J Ther Rehabil 2014;21:469-74.

22. Vega-López S, Chavez A, Farr KJ, Ainsworth BE. Validity and reliability of two brief physical activity questionnaires among Spanish-speaking individuals of Mexican descent. BMC Res Notes 2014;7:29.

23. Mokkink LB, Terwee CB, Patrick DL, et al. The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. J Clin Epidemiol 2010;63:737-45.

24. O'Brien KK, Bayoumi AM, Solomon P, et al. Evaluating a community-based exercise intervention with adults living with HIV: protocol for an interrupted time series study. BMJ Open 2016;6:e013618.

25. O'Brien KK, Davis AM, Chan Carusone S, et al. Examining the impact of a community-based exercise intervention on cardio-respiratory fitness, cardiovascular health, strength, flexibility and physical activity among adults living with HIV: a three-phased intervention study. PLoS One 2021;16:e0257639.

26. De Vet HCW, Terwee CB, Mokkink LB, Knol DL. Measurement in medicine. 10th ed. Cambridge University Press; Cambridge, United Kingdom: 2011.

27. Warburton DER, Jamnik VK, Bredin SSD, Gledhill N. The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). Health Fit J Can 2011;4:3-17.

28. Milton K, Bull FC, Bauman A. Reliability and validity testing of a single-item physical activity measure. Br J Sports Med 2011;45:203-8.

29. Larson JL. Functional performance and physical activity in chronic obstructive pulmonary disease: theoretical perspectives. COPD 2007;4:237-42.

30. Gimeno-Santos E, Frei A, Dobbels F, Rüdell K, Puhan MA, Garcia-Aymerich J. Validity of instruments to measure physical activity may be questionable due to a lack of conceptual frameworks: a systematic review. Health Qual Life Outcomes 2011;9:86.

31. Dagenais M, Salbach NM, Brooks D, O'Brien KK. Assessing the measurement properties of the Fitbit Zip® among adults living with HIV. J Phys Act Health 2020;17:293-305.

32. O'Halloran P, Kingsley M, Nicholson M, et al. Responsiveness of the single item measure to detect change in physical activity. PLoS One 2020;15:e0234420.

33. Riebe D, Ehrman JK, Liguori G, Magal M. ACSM guidelines for exercise testing & prescription. 10th ed. Philadelphia: Wolters Kluwer Health; 2018.

34. Ware Jr. JE. SF-36 health survey update. Spine (Phila Pa 1976) 2000;25:3130-9.

35. Strath SJ, Kaminsky LA, Ainsworth BE, et al. Guide to the assessment of physical activity: clinical and research applications. Circulation 2013;128:2259-79.

36. Terwee CB, Bot SDM, De Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. J Clin Epidemiol 2007;60:34-42.

37. Husted JA, Cook RJ, Farewell VT, Gladman DD. Methods for assessing responsiveness. J Clin Epidemiol 2000;53:459-68.

38. Choi EPH, Chin WY, Wan EYF, Lam CLK. Evaluation of the internal and external responsiveness of the Pressure Ulcer Scale for

Healing (PUSH) tool for assessing acute and chronic wounds. J Adv Nurs 2016;72:1134-43.

39. Guyatt G, Walter S, Norman G. Measuring change over time: assessing the usefulness of evaluative instruments. J Chronic Dis 1987;40:171-8.

40. Quigley A, Brouillette MJ, Gahagan J, O'Brien KK, Mackay-Lyons M. Feasibility and impact of a yoga intervention on cognition, physical function, physical activity, and affective outcomes among people living with HIV: a randomized controlled pilot trial. J Int Assoc Provid AIDS Care 2020; 19:232595822093569.

41. Lauzé M, Martel DD, Agnoux A, et al. Feasibility, acceptability and effects of a home-based exercise program using a geron-technology on physical capacities after a minor injury in community-living older adults: a pilot study. J Nutr Health Aging 2018;22:16-25.