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Use of real-time cadence to prescribe aerobic physical activity intensity and its comparison with existing methods

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ABSTRACT

The purpose of this study was to determine the effectiveness of physical activity intensity prescription using real-time cadence on achieving the required intensities for health benefits. Forty adults (18–65 years) participated in the study. The intensity prescriptions included Rating of Perceived Exertion, Talk Test, Heart Rate, and Real-Time Cadence. The participants performed a2-min trial for both moderate- and vigorous-intensity according to each prescription. Atri-axial accelerometer was used as acriterion measure. After completion of the trials, participant's preference for the prescriptions was assessed by three domains (e.g., understanding, performing, maintaining). The compliance and achievement rates of RC were calculated and compared to other prescription methods. Coefficient of Variance was used to evaluate the extent of variation of intensity during the trials. Higher compliance rates were found in both moderate- (92.1%) and vigorous-intensity (94.9%) when using RC. When using RC, most participants (92.5%) were able to achieve the targeted moderate-intensity, but not for vigorous-intensity although asignificant difference was found between the two intensities ($p < .001$). Overall, RC was the most favoured method in all three domains. RC is apromising tool to prescribe moderate-intensity of physical activity for health benefits but still needs to be refined on prescribing vigorous-intensity.

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KEYWORDS
Moderate-intensity; walking; prescriptions; health promotion; exercise

Introduction

Recently, additional health promotion effects of regular physical activity have been reported with various outcomes such as helping people achieve better sleep, better feeling, and easier performance of daily tasks. (2018 Physical Activity Guidelines Advisory Committee, 2018) Strong scientific evidence recommends that all adults should engage in at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic physical activity each week (i.e., preferably, spread throughout the week) for substantial health benefits. (U.S. Department of Health and Human Services, 2018) However, only 26% of men and 19% of women of the U.S. population, report sufficient activity to meet the guidelines presenting an opportunity for researchers and practitioners to devise targeted intervention programmes for physical activity promotion. (Tucker et al., 2011)

A simple and practical, yet precise, physical activity prescription is essential for promoting physical activity and maximizing the consequent health benefits. Among the parameters of physical activity prescription (i.e., frequency, intensity, time, and type of activity), intensity has been considered a central component of governmental physical activity guidelines (U.S. Department of Health and Human Services, 2018) and has received special attention due to its intrinsic difficulties in practical description (e.g., brisk walking for moderate intensity) compared to other parameters. Physical activity intensity can be described in both absolute and relative terms. Relative intensity describes an individual's level of effort required to perform an activity relative to one's cardiorespiratory fitness while absolute intensity refers to the amount of energy expended during the activity without considering an individual's cardiorespiratory fitness. (U.S. Department of Health and Human Services, 2018) Absolute intensity is usually expressed in multiples of the metabolic equivalent of task (MET) such as 3–5.99 METs (moderate intensity) and ≥ 6 METs (vigorous intensity), where 1 MET is equivalent to the absolute rate of energy expended while sitting at rest. (U.S. Department of Health and Human Services, 2018) As a rule of thumb for relative intensity, the rating of perceived exertion (RPE) and the talk test (TT) are commonly recommended in a daily living environment as a simple and practical prescription for physical activity intensity (Borg, 1982; Foster et al., 2008); however, the presence of wide individual variations, which can occur when using these self-determined methods, cannot be neglected. Instead, more accurate means of intensity prescription using particular equipment (e.g., activity monitors) such as percentage of aerobic power (VO_2max) or a percentage of maximal heart rate (HR)/HR reserve are often used as the relative parameters reflecting individual's physiological responses. (Garber et al., 2011; Nordsborg et al., 2010; Van Proeyen et al., 2011)

Recently, thresholds of moderate- and vigorous-intensity physical activity have been established using walking cadence (steps/min) corresponding to both absolutely and relatively determined intensities. (Abt et al., 2019; Tudor-Locke et al.,

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2018) Remarkable consistency has been found for a standardized, cadence value, particularly for moderate intensity at a population level, (i.e., 100 steps/min) associated with absolute intensity (≥ 3METs) that aligns with the current physical activity guidelines. (Tudor-Locke, Aguiar, Han, Ducharme, Schuna, Barreira et al., 2019; Tudor-Locke et al., 2020, 2018) Although further investigations are necessary to confirm this heuristic value when applied to individual samples, and also to consider other moderate-intensity cadence values determined based on relative measures (e.g., VO2reverve), this directly quantified method using more publicly understandable unit (i.e., steps/min) and favoured activity type (i.e., walking) may have the potential to improve understanding of intensity-based physical activity prescription in free-living environment. However, no studies are available to examine the potential of cadence-based intensity prescription, especially using real-time cadence, for achieving the desired intensities. Therefore, the primary purpose of the current study was to determine the effectiveness of physical activity intensity prescription using real-time walking cadence on achieving the required intensities for health benefits. In addition, a secondary purpose was to identify individual preference for the cadence prescription in comparison with commonly used pre-existing methods.

Methods

Participants

Forty healthy adults (age 18–65 years; 20 women) participated in the study. To identify the minimum number of participants required to achieve sufficient power, we conducted a priori power analysis for t tests with difference between two dependent means. (Abt et al., 2020) It is recommended to use a medium effect size of 0.50 (Henriksen et al., 2019) with an alpha of 0.05 and a power of 0.80. (Tabachnick & Fidell, 2013) Based upon results of the power analysis, a minimum of 34 cases was suggested. Participants were recruited using email advertisements, word of mouth, and flyers within the surrounding community. A written informed consent form was completed by all participants prior to the study experiment. Along with the consent form, participants were screened with the Physical Activity Readiness Questionnaire (PAR-Q). (American College of Sports Medicine, 2013) Participants were limited to those who had no cardiac history and who were able to complete multiple walking tests at moderate- and vigorous-intensity without using a walking aid. Exclusion criteria included the use of any known medications that alter the heart rate response (e.g., β-blockers), the diagnosis of any major diseases or illness, and the "yes" answer to any questions on the PAR-Q. The study protocol was approved by the Oklahoma State University Institutional Review Board.

Instruments

Criterion measure

A triaxial accelerometer (ActiGraph GT3X+; Pensacola, FL), a well-validated research-grade device, (Troiano et al., 2008) was used as the criterion standard to determine the extent to which each prescription achieved the desired intensities (i.e., moderate- and vigorous-intensity). Although the use of indirect calorimetry may provide more valid thresholds of the intensities, the current study used an accelerometer because it is more realistic and widely used in measuring physical activity intensity in free-living environment. Participants wore the accelerometer on their right hip throughout the study protocol. The accelerometer data were collected at 80 Hz and aggregated to 1-second epoch for analyses. Consistent with the National Health and Nutritional Examination Survey (NHANES) cut points, we applied the minimum cut-points of 2020 and 5999 counts per minute (c/m) for moderate- and vigorous-intensity, respectively. (Troiano et al., 2008)

Wearable activity monitors

The Polar H10 Heart Rate Monitor with the Polar Pro chest strap was used for the heart rate prescription. The strap was fastened around the chest and was adjusted to fit snugly. The H10 was also paired with a wrist device, Polar M430 (Polar Electro, Kempele, Finland), to provide heart rates in real-time. Heart rate was measured with the H10 instead of using a built-in heart rate monitor in the M430, and the heart rate measured by H10 was displayed on M430. Validations reporting very high correlations and narrow limits of agreement have been observed in several studies. (Henriksen et al., 2019) Heart rate data were automatically transmitted to the Polar Beat application for the analyses. A cadence sensor, Garmin Foot Pod, paired with a wrist device, Garmin Forerunner 235 (Garmin Ltd., Olathe, KS), was used for the method using real-time cadence (RC). The cadence sensor was attached to a foot while transmitting the real-time cadence value to the wrist device. The accuracy of these devices was previously reported. (Han et al., 2019)

Assessment of preference for physical activity intensity prescription

Individual preference for the prescriptions including (1) RPE, (2) TT, (3) HR, and (4) RC was assessed by three domains: (1) easy-to-understand the prescription, (2) easy-to-perform the prescribed intensity, and (3) easy-to-maintain the prescribed intensity for a given duration. For each domain, the prescriptions were ranked in order of individual preference and scored 4 (first rank) to 1 (fourth rank) corresponding to the rank.

Protocol

After the completion of informed consent, participants wore the aforementioned electronic devices according to the manufacturer's instructions. Resting HR was measured after 20 minutes of comfortable rest in a supine position in bed. Maximum HR was estimated by subtracting participant's age from 220. Each participant's HR ranges corresponding to moderate- and vigorous-intensity were determined using the heart rate reserve (HRR) method (i.e., subtracting resting HR from maximum HR). (American College of Sports Medicine, 2013)

Physical activity trials

Intensity-focused physical activity prescriptions used for describing moderate- and vigorous-intensity in the current study included (1) RPE, (2) TT, (3) HR, and (4) RC. The

Table 1. Description of each prescription for moderate- and vigorous-intensity.

	Physical Activity Intensity Prescriptions			
Intensity	RPE	TT	HRR (%)	RC (steps/min)
Moderate	5–6 out of 10 (Somewhat hard or hard)	You can talk but can't sing while doing an activity	40–59	100–129
Vigorous	7–8 out of 10 (Hard or very hard)	You will not be able to say more than few words without pausing for a breath	60–85	≥130

HRR = heart rate reserve; RC = real-time cadence; RPE = rating of perceived exertion; TT = talk test.

details of each prescription describing moderate- and vigorous-intensity are reported in Table 1. Each participant completed a total of 8 physical activity trials (e.g., moderate- and vigorous-intensity x 4 physical activity prescriptions). Participants were asked to continuously walk and/or run at researcher-prescribed intensity for 2 minutes in an indoor basketball court (i.e., marked using 4 cones) followed by a minimum of 2-min break. A sufficient amount of an extra time was provided at the beginning of each trial for the participants to achieve the prescribed intensity, and the 2-min trial began with the participant's sign of readiness. The self-determined methods (i.e., RPE and TT) were always performed first in a random order. The remaining trials were counter-balanced. Participants provided feedback (e.g., preference) on the prescriptions at the end of each trial.

Data processing

A compliance rate herein refers to how well the participants understood and appropriately performed a given intensity prescription. Participants were considered as complying with the intensity prescription when their mean values (i.e., HR or cadence) fell within the given range of prescribed intensity. Self-determined intensity methods (RPE and TT) were excluded for this calculation as no numerical standards were available to determine for the methods. A mean of activity counts (counts per minute) from the criterion measure was calculated for the physical activity intensity performed during each trial. When the activity counts fell within the targeted intensity ranges (i.e., between 2020 and 5998 c/m for moderate-intensity and ≤ 5999 c/m for vigorous-intensity), (Troiano et al., 2008) it was considered as achieving the intensity (i.e., achievement rate).

Data analysis

Descriptive statistics were used to summarize participant characteristics and presented as mean ± standard deviation. A paired t-test was used to compare the activity counts derived from each trial. An alpha was set to .0125 or .025. Coefficient of Variance (CoV) was used to evaluate the extent of variation of intensity during the trials. Lastly, one-way repeated measures analysis of variance (ANOVA) with Mauchly's sphericity test were conducted for the comparison of prescription preferences. All statistical analysis was conducted using IBM SPSS 25 for Windows.

Results

Participant characteristics (mean ± SD age of 22.1 ± 4.3 years, mean BMI of 24.0 ± 4.3 kg/m^2, mean resting heart rate of 78.3 ± 15.7, 55.0% White, 15.0% Black, 12.5% Asian, 10.0% Others, and 7.5% Hispanic) are given in Table S1. Skewness/Kurtosis test and Shapiro-Wilk tests supported distributions of mean MHRR, cadence, and activity counts were normal ($p > .05$). Also, assumption of sphericity was not violated ($p > .05$).

Compliance rates, consistency of intensity remained throughout the trials, and activity types performed for adhering to a given prescription were summarized in Table 2. Greater compliance rates were found for both moderate- (92.1%) and vigorous-intensity (94.9%) when using RC compared to HR (76.9% and 69.2%). For both methods, the means of each outcome (MHRR or RC) fell within the targeted ranges of intensities. When the participants were prescribed for both moderate- and vigorous-intensity activities using RC, the majority of the participants chose walking to comply to the instruction, whereas a combination of walking and running, or running was preferable to achieve the targeted intensity when HR was used. The ranges of CoV were 13.0 to 28.6 and 14.9 to 23.6 for moderate- and vigorous-intensity, respectively. A lower variation (13.0) in performing moderate-intensity was found when using RC than TT (14.8), RPE (14.8), and HR (28.6) (Figure S1A). For vigorous-intensity, RC (14.9) also had a lower variation compared to others (17.2, 17.6, and 23.6 for TT, RPE, and HR, respectively) (Figure S1B).

The achievement rate of each prescription method with a mean of activity count was presented in Table 3. When using RC, most participants (92.5%) were able to achieve the targeted moderate intensity followed by HR (47.5%), TT (45.0%), and RPE (22.5%). In contrast, RPE (82.5%) was the most achievable method when prescribing vigorous intensity followed by HR (72.5%), TT (72.5%), and RC (45.0%). Significant differences in activity counts were found between moderate- and vigorous-intensity when using HR ($p < 0.001$) and RC ($p < 0.001$), whereas no significant differences were observed with RPE ($p = 0.717$) and TT ($p = 0.284$).

Individual preferences for currently available intensity prescription methods were illustrated in Figure 1. Overall, RC was the most favoured method by the participants in all three

Table 2. Compliance rates, mean MHRR, mean cadence, consistency of intensity remained throughout the trials of moderate- and vigorous-intensity for HR and RC.

Methods	Intensity	Compliance rate (%)	Mean MHRR (%; 95% CI)	p	d	Mean Cadence (steps/min; 95% CI)	p	d	CoV (95% CI)	Activity Type (n (%)) W	W&R	R
HR	Moderate	76.9%	51.6 (48.7, 54.6)	<.001	1.87	134.2 (119.5, 148.9)	<.001	1.14	28.6 (3.9, 53.2)	7 (17.5%)	30 (75.0%)	3 (7.5%)
	Vigorous	69.2%	68.2 (56.0, 71.4)			150.8 (134.5, 167.1)			23.6 (0.1, 47.10	1 (2.5%)	26 (65.0%)	13 (32.5%)
RC	Moderate	92.1%	47.5 (39.6, 55.5)	<.001	1.34	121.2 (110.4, 132.0)	<.001	1.37	13.0 (3.9, 22.0)	39 (97.5%)	1 (2.5%)	0 (0.0%)
	Vigorous	94.9%	64.1 (50.6, 77.7)			144.1 (119.3, 168.8)			14.9 (−0.1, 29.9)	26 (65.0%)	10 (25.0%)	4 (10.0%)

Significant difference between the intensities at $P < 0.025$; CI: confidence interval; CoV = coefficient of variance; d = Cohen's d; HR = heart rate; MHRR = maximum heart rate reserve; R = running; RC = real-time cadence; W = walking; W&R = a combination of walking and running.

domains. RC had the highest mean score of 3.55/4.00 followed by HR (3.02), TT (1.87), and RPE (1.55), and the score was significantly higher than other methods ($p < .001$) in the domain of easy-to-understand prescription (Figure 1A). For the domain of easy-to-perform the prescribed activity, RC also received the highest score (3.46/4.00) followed by HR (2.43), TT (2.10), and RPE (2.00). The mean score was significantly higher than other methods ($p < .01$). Lastly, for easy-to-maintain the prescribed intensity for a given duration, the highest score was found in RC (3.22/4.00) followed by TT (2.47), and HR/RPE (2.15 for both). A significant difference was found between RC and other methods ($p < 0.01$). In addition to the means of ranked scores, the frequency of the first-ranked method was described in Figure 1B. RC was most frequently ranked first by the participants in all domains (e.g., 62.5%, 70%, and 67.5%, respectively).

Discussion

The main purpose of this study was to examine the effectiveness of a physical activity intensity prescription using real-time cadence on achieving desired intensities for health benefits. In addition, individual preference for the RC prescription was identified by comparing to other commonly used pre-existing prescriptions. The primary finding of the current study was that the intensity prescription using RC generally demonstrated higher rates of compliance and achievement compared to other methods. However, more than half of the participants failed to achieve vigorous intensity when it was prescribed using RC even though the mean intensity performed was significantly higher than the mean of moderate intensity. In addition, the participants more consistently remained at the targeted intensity in a given duration when using RC compared to other methods. For both moderate- and vigorous-intensities, walking was a dominant type of activity the participants chose to comply with the prescription when using RC, whereas a combination of walking and running was mainly used for other prescriptions. Lastly, RC was the most favoured by the participants to understand the prescription, to perform the prescribed intensity, and to maintain the prescribed intensity for a given duration.

The Physical activity prescription typically refers to the specific instruction for a specified purpose such as fitness improvement and rehabilitation. In the current study, intensity-focused physical activity prescriptions were tested for the general population to achieve a targeted intensity in accordance with the governmental physical activity guidelines. Successful compliance with prescribed intensity of physical activity (e.g., maintaining 40–59% of HRR for moderate intensity during a given period of time) is vital for maximizing the health effects. In other words, failure to comply with prescribed intensity may attenuate the effectiveness of physical activity interventions on health outcomes. In this study, greater compliance rates were observed for both moderate- and vigorous-intensity with an average of 92.1% and 94.9%, respectively when using RC compared to HR. Potentially, the differences in variability of estimates between RC and HR may lead to the gaps. Unlike RC which is responding immediately to intensity changes, HR is often accompanied by a lag. (Jeukendrup & Diemen, 1998) At the intensity transition, gradual response of HR occurs, resulting in providing unreliable intensity

Table 3. Achievement rate and activity counts of each prescription method for moderate- and vigorous intensity.

Methods	Intensity	Achievement Rate	Activity Counts (counts/min; 95% CI)	p	d
RPE	Moderate	22.5%	7635.4 (6930.3, 8340.5)	0.717	0.06
	Vigorous	82.5%	7723.2 (7045.5, 8400.9)		
TT	Moderate	45.0%	6902.2 (6127.2, 7677.1)	0.284	0.17
	Vigorous	72.5%	7244.7 (6528.7, 7960.7)		
HR	Moderate	47.5%	5381.2 (4858.7, 5903.6)	<.001	0.94
	Vigorous	72.5%	6795.9 (6254.1, 7337.8)		
RC	Moderate	92.5%	4116.3 (3798.1, 4434.4)	<.001	0.83
	Vigorous	45.0%	5535.1 (4950.0, 6120.1)		

Ranges of activity count = 2020 ≤ moderate-intensity < 5999 and 5999 ≤ vigorous-intensity, respectively; Significant difference between the intensities at $P < 0.0125$; CI = confidence interval; d = Cohen's d; HR = heart rate; RC = real-time cadence; RPE = rate of perceived exertion; TT = talk test.

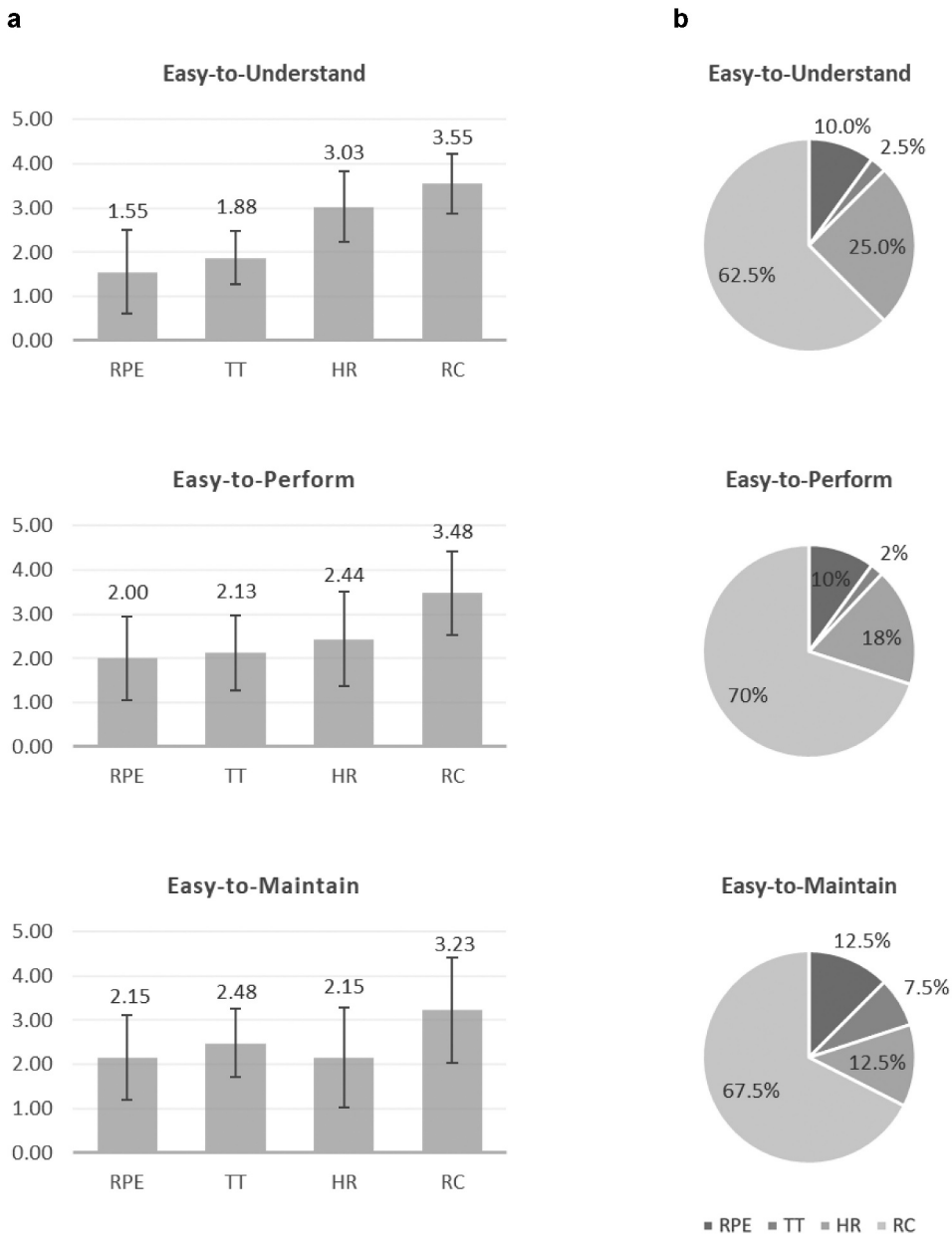

Figure 1. Individual preference of intensity prescription methods. a: means of ranked scores; b: frequency of the first-ranked method. HR = heart rate; RC = real-time cadence; RPE = rate of perceived exertion; TT = talk test.

indices during physical activity. Also, HR is influenced by several internal and external factors, such as terrain, stress, weather, time of day, and smoking, in addition to the performance itself. (Achten & Jeukendrup, 2003) These phenomena can cause irregular HR variability which might hinder the participants' ability to maintain a targeted intensity when using the HR prescription. To the authors' knowledge, this was the first study identifying individual capability to maintain a prescribed intensity using real-time cadence for a given period of time. The prescribed intensity remained relatively constant throughout the trials when RC was utilized as an intensity indicator. The findings in CoV estimates and types of physical activity performed for adhering to prescribed intensity also support the ability of RC to prescribe physical activity intensity. Lower estimates of CoV for both moderate- and vigorous-intensities were found in this study when using RC prescription compared to the HR indicating less variation occurred in maintaining a prescribed intensity. The low variation of RC also enables the participants to maintain a prescribed intensity by using a single type of activity (i.e., walking), unlike HR which often requires both walking and running, suggesting the potential of RC for improving individual ability to comply with targeted intensity of physical activity.

In addition to the compliance rate, it was also necessary to examine whether the desired intensity would be achieved by an individual performing physical activity in accordance with an intensity prescription. In general, the achievement rate for moderate-intensity herein were relatively higher with the device-based prescriptions (e.g., HR and RC) compared to those relying on self-determined intensity (e.g., RPE and TT). As a reason for the low

achievement rate with the methods using self-determined intensity, most participants overestimated their perceived moderate-intensity, in turn, resulting in performing vigorous-intensity activity that was fairly similar to the intensity they performed when vigorous-intensity was prescribed. Only device-based prescriptions (HR and RC) were able to significantly differentiate between moderate- and vigorous-intensity ($p < 0.001$). Particularly, outstanding performances on achievement rate (92.5%) and intensity differentiation ($p < 0.001$) were observed with RC prescription, suggesting that RC could be an effective alternative to currently existing intensity prescriptions, especially when it is used for clinical purposes requiring a specific and precise intensity prescription. In contrast to the result for moderate-intensity, the lowest achievement rate (45%) compared to the other methods was found in RC prescription when vigorous-intensity was targeted. Despite the fact that the participants performed physical activity at the mean cadence of 144.1 steps/min indicating much greater cadence than the prescribed minimum vigorous-intensity threshold (i.e., RC > 130 steps/min), their mean activity count (5535.1 counts/minute) was a bit short of the minimal cut-point of vigorous-intensity (e.g., 5999 counts/min). This result suggests that further investigation may be required to refine the cadence threshold for vigorous-intensity as the current threshold of 130 steps/min is a heuristic value associated with 6 METs which is a generalized, broadly representative information to indicate the vigorous-intensity. (Tudor-Locke, Aguiar, Han, Ducharme, Schuna, Barreira et al., 2019) Despite the lower average rate of achieving vigorous-intensity, the performed-intensity using RC remained consistent during a given time, similar to moderate-intensity, with a relatively low estimate of CoV. Given the consistent variation and successful differentiation between intensities, RC would be still appropriate to prescribe a particular intensity of physical activity for public health purposes when it is accompanied with the cut-point adjustment for vigorous-intensity.

Individual preference for an intensity prescription should be an essential consideration in method selection to maximize both compliance rate and achievement rate and thereby the optimal health outcomes of an intervention programme. We found that RC prescription was the most favoured by the participants in all domains; therefore the prescription using RC was considered the easiest method to understand the prescription, to perform the prescribed intensity, and to maintain the prescribed intensity for a given duration. This could be explained by the practical and functional characteristics of walking. Walking is an important part of daily living for most people and one of the most popular types of physical activity performed by all age groups worldwide. (Hulteen et al., 2017) In addition, as intensity is a direct reflection of cadence, a temporal and spatial metric of walking, (e.g., an increase in intensity as cadence increases), the targeted intensity can be easily achieved and performed by complying with the RC prescription. (Tudor-Locke, Aguiar, Han, Ducharme, Schuna, Barreira et al., 2019) Thus, cadence may be more familiar and understandable for the general population when it was used for intensity prescription. These results may also explain the reason for the high compliance rate of RC in this study and support the effectiveness of RC prescription to achieve a targeted intensity for health benefits.

A couple of study limitations should be considered. In the present study, Troiano's cut-points (Troiano et al., 2008) were used to determine the intensities of physical activity, but there still exist additional options in the literature. These thresholds may differently contribute to the results of the present study. However, Troiano's cut-points were chosen to maintain consistency with the NHANES and many other national measures of physical activity. (Crouter et al., 2013; Troiano et al., 2008) Next, the present study used accelerometer-derived estimates as a criterion measure instead of using indirect calorimetry providing more valid thresholds of the intensities. Accelerometer may be a more feasible and practical option to determine physical activity intensity performed in free-living environment compared to sophisticated laboratory techniques (e.g., indirect calorimetry). Lastly, we acknowledge that real-time cadence is mostly applicable to walking or running behaviours. However, it would still provide meaningful information to indicate the intensity of the bipedal locomotor movements, which is an essential component of everyday life for most people. As the strengths of the current study, these results are the first evidence of the effectiveness of real-time cadence to prescribe physical activity intensity in comparison to other pre-existing methods. Also, the study focused on the intensity of physical activity using real-time cadence performed in free-living setting. The findings could be widely applicable to various walking interventions in free-living to promote physical activity and to obtain health benefits.

Overall, the effectiveness of RC to achieve desired intensities and individual preferences for the RC prescription were examined in the present study in comparison to commonly used pre-existing methods (e.g., RPE, TT, and HR). Participants were more compliant with a prescription and achieved targeted intensity when RC was used for the prescription compared to other methods. However, further research is warranted to confirm the stable result of RC prescription for vigorous-intensity. Lastly, RC was the most preferable to the participants in all three domains including easy-to-understand the prescription, easy-to-perform the prescribed intensity, and easy-to-maintain the prescribed intensity for a given duration. Given these findings, RC could be an effective means for prescribing physical activity intensity, especially for moderate-intensity, and, in turn, it would elicit improvements in

providing more easily understandable and reliable prescription to achieve targeted physical activity intensity in both free-living and clinical settings.

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Supplement material

Supplemental material for this article can be accessed here

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