Effects of Music Stepping Cadence on 3-min Step Test Performance in Hong Kong Females
節奏強烈的音樂拍子對女性在三分鐘登臺階測試表現之探討

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Abstract

This study compared the performance of university females in Hong Kong with different ages and physical activity participation levels on two 3-min step-tests using different cadences. Fifty-six students were classified into three groups. They performed two step-tests randomly on a 30-cm high bench with metronome (MN) and hip-hop music (HH) cadences at 96 beat·min^{-1} with 60 min rest between. The preference of either cadence was indicated upon completion of both. Rate of perceived exertion was reported at 2-min (RPE_2) and 2.5-min ($RPE_{2.5}$). Heart rates at rest (by monitors, HR_r) and 1-min post-exercise (by monitors, HR_h; by pulse, HR_p) were recorded. Results indicated that more than 80% of them preferred HH. Among all groups, although paired t-tests showed no significant differences ($p>0.05$) between the performance of MN and HH, the latter elicited a higher HR_p, HR_h, RPE_2 and $RPE_{2.5}$, and both cadences were highly correlated ($r=0.70$-0.91, $p<0.001$). MANOVA showed no significant differences for the responses of HR_p, HR_h, RPE_2 and $RPE_{2.5}$ under the two stepping cadences (Hotelling's Trace=0.27, $p>0.05$). There was no interaction between age and physical activity participation level (Hotelling's Trace=0.23, $p>0.05$). HH seemed a reliable cadence for 3-min step-test in females of different ages and physical activity participation levels.

Keywords: heart rate, music cadence, physical fitness, step test

摘　要

本研究探討採用音樂與節拍器拍子於三分鐘登臺階測試對不同年齡和運動習慣的女生之影響。五十六名女生根據她們的年齡和參與運動習慣分成三組。她們以隨機排序採用節奏強烈的音樂和傳統節拍器拍子完成兩次三分鐘登階測試。每次測試相距不少於六十分鐘。結果顯示超過八成女生較喜用音樂拍子，她們在兩種拍子的身體反應並無差異(P>0.05)，年齡和參與運動習慣並無互動效果。結果證實在三分鐘登臺階測試中音樂拍子可以有效地取代單調節拍器拍子。

Introduction

The 3-minute (min) step test is a popular submaximal field test to assess cardiorespiratory fitness in community and occupational health settings. It is easy to administer, does not need sophisticated laboratory equipment, and the result is easy to interpret. The bench stepping tests were developed with single stage and multistage protocols. Several researchers examined the efficiency of stepping and found it related to physical

characteristics of the participants such as stature (Ashley, Smith & Reneau, 1997), age (Astrand, 1960), leg length (Culpepper & Francis 1987), and body weight (Marriott & Gumstrup-Scott 1992). Numerous studies also investigated the effect of other factors including the methods of heart rate measurement, tempo and step height on the stepping test performance (Francis & Brasher, 1992; Francis & Culpepper, 1988; Golding 2000; McArdle, Katch & Katch, 1991). Some protocols have been developed for different populations such as children (Hui & Cheung, 2004), college students (McArdle, Katch & Katch, 1991) and elderly (Petrella, Koval, Cunningham & Paterson, 2001). However, the widely used monotony metronome stepping cadence in 3-min step test provides less motivation and enjoyment for the participants especially those considered unfit. When the test is compulsory, the willingness to complete it is questionable, let alone using it for continual monitoring of cadiorespiratory fitness.

Music has been demonstrated to facilitate exercise performance (Karageorghis & Terry, 1997; Lucaccini & Kreit, 1972) by enhancing arousal (Karageorghis, Drew & Terry, 1996;), enjoyment (Becker et al., 1994; Brownley, Murray & Hackney, 1995; Karageorghis & Terry, 1997) and exertion tolerance (Dalton & Behm, 2007; Karageorghis & Terry, 1997). Several studies have investigated the effect of different music characteristics such as its type (Potteiger, Schroeder & Goff, 2000; Tenenbaum et al., 2004), tempo (Edworthy & Waring, 2006; Nittono, Tsuda, Akai & Nakajima, 2000) and volume (Copeland & Franks, 1991) on human task performance. The application of music instead of the monotony metronome stepping cadences in 3-min step test has been suggested to give better motivation and enjoyment for the participants. Few published studies have investigated the possibility of the use of music as a pace to replace the monotony metronome stepping cadences in a single stage 3-min step test.

Ng and Lin (2007) examined the test-retest reliability among 82 (42 females and 40 males) tertiary education students in Hong Kong using the metronome (MN) and hip hop music (HH) stepping cadences, both at 96 beat·min^{-1} on 30 cm high bench in a single stage 3-min step test. The intraclass correlation coefficients were 0.64 and 0.66 for MN and HH stepping cadences respectively. However, the applicability of the HH stepping cadence on female participants with different backgrounds such as age and physical activity participation level was not evaluated. Therefore, the purpose of this study was to compare the performance of single stage 3-min step test using two stepping cadences in Hong Kong females from different age groups and of different physical activity participation levels.

Method

Participants

Fifty-six Chinese women (mean age 27.1 ± 9.4 years; range 18.6 – 57.7) voluntarily participated in this study with informed consent. Table 1 shows their physical characteristics. They were classified into three groups according to their age and physical activity participation level. The young sports representatives (YSR) spent at least 120 min exercising in team training twice weekly. Both young and mature non-sports representatives (YNR and MNR) reported no regular exercise participation. The mature students were those aged 25 or above by the test date. All participants completed the Physical Activity Readiness Questionnaire (Canadian Society for Exercise Physiology 2002) which indicated that they were physically fit for the test. They were requested to abstain exercise, food, alcohol and caffeine consumption 4 hours prior to the test. All participants had no experience in step test and the use of the rate of perceived exertion (RPE) scale. Their weight and height were measured using Easy Glide Bearing Stadiometer (Perspective Enterprises, Portage, MI, USA) and the Seca model 882 digital scale in repletion.

Table 1. Physical Characteristics of the 56 Participants.

Participants	n	Age (years)	Height (m)	Weight (kg)	BMI (kg·m^{-2})
YSR	21	21.9 ± 1.7	1.63 ± 0.05	56.5 ± 6.7	21.1 ± 2.0
YNR	17	21.3 ± 2.3	1.56 ± 0.06	54.4 ± 15.1	22.2 ± 6.2
MNR	18	38.6 ± 8.3	1.58 ± 0.06	53.6 ± 7.6	21.5 ± 2.6

*Data are presented as mean ± standard deviation. BMI = body mass index

Step Test Protocol

The present study was modified from the Queens' College Step Test protocol (McArdle et al., 1972). Participants performed two 3-min stepping exercises on a bench with 30 cm height using MN and HH stepping cadences, both at 96 beat·min^{-1}. During the test, participants reported the RPE at 2-min (RPE_2) and at 2.5-min ($RPE_{2.5}$) of stepping using the 10-point Borg RPE scale. Heart rates were recorded while sitting at rest (HR_r) and 1 min after the 3-min stepping (HR_h) using PE-4000 Sport Tester (Polar Electro KY, Kempele, Finland). Trained testers monitored the stepping pace of the participants during the test and recorded the 1-min post exercise heart rate (HR_p) within 5 seconds after the 3-min of stepping while the participant was sitting. Stepping performance during the test was video recorded for analysing any incorrect stepping tempo and techniques. Participants reported their preference of the cadence based on an overall feeling after both tests completed.

Procedures

The tests were carried out in an air-conditioned dancing room where the temperature was kept at 23°C. After explaining the test procedure, a 10-min standardised warm-up, and a trial of the tempo on a 30 cm high bench, the participants performed two 3-min step tests of MN and HH stepping cadences, both at 96 beat·min^{-1}. The two tests were conducted in a randomised order with at least 60 min rest between.

Statistical Analysis

Descriptive statistics were reported as mean and standard deviation (SD). A series of paired t-tests were used to assess the statistical significance between the mean values for the two stepping performance using the SPSS for Windows software package (Version 17). A multivariate analysis of variance (MANOVA) was performed to compare HR_p, HR_h, RPE_2 and $RPE_{2.5}$ for different age groups and physical activity participation levels. An alpha level of 0.05 was used for all statistical tests.

Results

One-way ANOVA showed no significant differences among the three groups' BMIs ($F_{2, 53} = 0.33$, $p = 0.72$), HR_r ($F_{2, 53} = 0.03$, $p = 0.98$), HR_p in MN cadence ($F_{2, 53} = 0.13$, $p = 0.88$) and HR_p in HH cadence ($F_{2, 53} = 1.98$, $p = 0.15$).

Among all groups, although the results of a series of paired t-tests showed no significant differences for the responses of HR_p ($t_{55} = 0.61$, $p = 0.55$), HR_h ($t_{55} = 1.18$, $p = 0.24$), mean RPE_2 ($t_{55} = 0.56$, $p = 0.58$), and mean $RPE_{2.5}$ ($t_{55} = 0.43$, $p = 0.67$) between the performance in MN cadence and HH cadence, the latter elicited a higher HR_p, HR_h, RPE_2 and $RPE_{2.5}$ (see Table 2). Pearson correlations (r) showed a significant relationship between MN and HH cadences for RPE_2 ($r = 0.75$), $RPE_{2.5}$ ($r = 0.70$), HR_p ($r = 0.87$) and HR_h ($r = 0.91$).

Table 2. Comparison of Heart Rates and RPE Responses among the Three Groups using Metronome Cadence and Hip Hop Music Cadence (n=56).

Measurement	Group	n	Metronome cadence (MN)	Hip Hop music cadence (HH)
RPE at 2-min (1-10 unit scale) (units)	YSR	21	3.5±1.3	3.4±0.9
	YNR	17	2.2±1.2	2.1±1.2
	MNR	18	3.2±1.4	3.6±1.4
	Total	56	3.0±1.4	3.1±1.3
RPE at 2.5-min (1-10 unit scale) (units)	YSR	21	4.1±1.5	3.9±0.9
	YNR	17	2.7±1.6	2.6±1.4
	MNR	18	3.8±1.4	4.7±1.9
	Total	56	3.6±1.6	3.8±1.6
1-min post exercise heart rate (beat·min^{-1})	YSR	21	107.1±22.6	107.8±21.1
	YNR	17	108.5±20.4	114.9±23.9
	MNR	18	104.9±21.0	99.2±25.8
	Total	56	106.8±21.1	107.7±22.8
Heart rate at 1-min after the 3-min stepping (beat·min^{-1})	YSR	21	99.1±21.6	98.5±21.8
	YNR	17	117.7±12.5	118.9±16.9
	MNR	18	113.9±14.8	115.5±16.4
	Total	56	108.8±19.2	109.3±21.1

*Data are presented as mean ± standard deviation.

The MANOVA with respect to two stepping cadences (HH and MN) resulted in non-significant differences for the responses of HR_p, HR_h, RPE_2 and $RPE_{2.5}$ (Hotelling's Trace = 0.027, $F_{4,44} = 0.29$, $p > 0.05$). There was no interaction among the types of stepping cadence, the level of physical activity participation and age (Hotelling's Trace = 0.021, $F_{4,43} = 0.23$, $p > 0.05$).

The majority (80.4%) of the participants reported they preferred the HH cadence. Most participants had no difficulty in keeping time with the MN and HH rhythms, despite two participants had excessive hand movement in HH cadence which were rectified by the tester verbally emphasising the correct rhythm.

Discussion

The present study compared the performance of two single stage 3-min step tests using HH and monotony MN stepping cadences in Hong Kong females from different age groups and of different physical activity participation levels. Statistical tests did not reveal any significant differences in stepping performance between HH and MN stepping cadences of the same tempo. The stepping performance showed similar patterns during 3-min step test with HH and MN stepping cadences, no interaction was observed among the stepping cadences, physical activity participation level and age of the participants.

The findings indicated that the reported RPE_2 and $RPE_{2.5}$ were lower for the group of YSR and YNR when performing 3-min step tests using HH cadence, although their measured mean HR_p were higher than that with MN cadence. This supports the views of Karageorghis and Terry (1997) and Rejeski (1985) that music can provide a distraction from the perceived exertion and thus reduce RPE during submaximal exercise. Similar issues were identified by Nobel and Robertson (1996) that the situational and dispositional factors accompanied with music such as level of motivation, and focus of attention can affect the perception of exertion during exercise. In comparison with the responses of RPE_2 and $RPE_{2.5}$ from MNR, it is noteworthy that the mature participants expressed higher perceived exertion than their youthful counterparts when performing the test with HH stepping cadence. Further research is urged to increase our understanding of the effect of the age, the fitness level of the participants, or the interaction of both factors on their perception of effort.

All participants completed both tests without feeling pain or discomfort during the tests. The reported RPE_2 and $RPE_{2.5}$ showed that their perceived effort fell between "easy" and "just feeling a strain" during the test. No participants failed to maintain the correct stepping tempo in both stepping cadences. This supports the views of Karageorghis and Terry (1997) that music encouraged participants synchronized their movements to the music. This is in variance with the findings of Styns and his coworkers (2007) that people over-reacted on music than on metronome stimuli of the same nominal tempo in basic motor activity such as walking.

The majority reflections of the participants did indicate a greater preference for HH music as stepping pace, which implied that the use of music cadence in step test may be a viable way of positively influencing an individual's disposition during testing, thereby enhancing the enjoyment of the experience. This is in line with the findings of Tenenbaum and his co-workers (2004) that music can make the exercisers feel joy, motivated, and attention-directed. Using music as stepping pace in a single stage 3-min step test apparently both distracted and motivated the participants to exercise and enhanced their enjoyment. More research is needed to enhance our knowledge of the effects of music on stepping performance in children and male participants. The effect of different characteristics of music such as style, tempo, loudness as well as participants' music preference on stepping performance, and on the prediction of aerobic capacity should be verified by further research.

In conclusion, the single stage 3-min step-test using HH stepping cadence appeared to be good alternative to provide tempo for step testing among Hong Kong females with different age group and physical activity participation level.

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