

Running At 'Pace with A Smile' Exceeds Intensity of Lactate Threshold in Elderly People

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Abstract

Aim: Moderate exercise intensity at the lactate threshold (LT) is considered to be the minimal intensity required to increase aerobic capacity.

Purpose: The purpose of this study was 1) to examine the benefit of running at a pace at which the runner can run with a smile ('pace with smile' / RPS) to compare LT in running and 2) to examine how much the LT speed in running differed from preferred transition speed (PTS) in 17 elderly people (Age: 71.0±5.2 yr, Height: 154.4±7.6 cm, Body mass: 56.7±8.0 kg, BMI: 23.8±2.7 kg/m²).

Methods: An outdoor test of 1 min RPS was carried out based on 10-12 of Borg's RPE scale (around 'fairly light') or at perceived smiling and talking level, and distance was measured in order to calculate running speed. LT in running was determined by incremental exercise test. PTS was determined as a natural walk-run transition speed by increasing treadmill speed from low to high, and reducing it from high to low for run-walk transition. These tests were randomized.

Results: Even if prescribing running at smiling and talking level, the speed of RPS exceeded the LT speed in running (6.6±0.5 vs. 4.8±0.8 km/h, P<0.01). LT speed in running was significantly lower than PTS (4.8±0.8 vs. 5.9±0.7 km/h, P<0.001).

Conclusion: These data indicated that 1) Running at smiling pace easily exceeds the aerobic training threshold and 2) LT speed in running is slower than PTS, indicating that slow-jogging at walking speed is optimal in elderly people.

Keywords: Pace with a smile; Lactate threshold; Running; Preferred transition speed

Introduction

Moderate exercise intensity at lactate threshold (LT) is considered to be the minimal intensity required to increase aerobic power [1]. We have shown that bicycle ergo meter training at LT improved glucose tolerance [2], hypertension [3], and dyslipidemia [4], and bench stepping training at LT increased leg extension power [5]. By using these apparatus, it is possible to give a stable load to exercisers. However, if expanding versatility of exercise, simple exercise mode would be desirable that anybody can do at anywhere and anytime without using exercise apparatus. With this kind of background, we have recently recommended slow-jogging at walking speed based on LT intensity, especially to elderly people as well as those with low

fitness level [6, 7, 8].

Regarding jogging, commercially available heart rate monitor is convenient to set an individual exercise intensity, but Borg's rating of perceived exertion (RPE) scale is thought to be realistic and simple method to set an optimal exercise intensity for elderly people [9]. RPE at LT in running has been reported in numerous studies. These RPE responses are within the range of RPEs reported in previous studies, such as 10.8±1.8, 11.2±2.1, 11.2±2.3, 11.2±2.1 [12], 11.6±0.7 and 11.0±1.1 [10-14]. In light of these data, it is expected that one can run at LT intensity if prescribed based on 10-12 of RPE scale.

We conducted a randomized control trial for community-dwelling elderly people aged 70.4±4.1, demonstrating that Metabolic Equivalents (METs) at LT was 3.8±0.5 before intervention, which was calculated 2.9 km/h of running speed [6,15]. Given that the speed human preferably transition from walking to running (Preferred Transition Speed or PTS) is 5.9-7.9 km/h, LT in elderly people is within the range of walking speed. There is no significant difference in PTS between runners and non-runners, suggesting that PTS is not affected by aerobic capacity [16-19]. If the elderly people run around PTS, they can easily exceed the LT intensity.

So far, we have called a pace at RPE 10-12 or LT intensity 'Pace with a Smile' to make this phrase generally known. The purpose of this study was to test the hypothesis that running at pace with a smile (RPS) can exceed LT intensity. Therefore, three tests were randomized as follows; 1) outdoor test of 1 min RPS, 2) treadmill test of running to determine LT intensity and 3) test of PTS. It is still unclear whether RPS exceeds LT intensity or not, or become high intensity exercise in elderly people. It is clarified that when running based on RPE obtained from the graded exercise test, it becomes faster than the speed on the treadmill [20,21]. However, our research design is that runs directly based on 'pace with a smile' to confirm whether it exceeds LT intensity.

Most people tend to have an impression that running is a hard exercise. But, if this hypothesis is verified and it is found that even if running at pace with a smile exceeds the threshold at which aerobic capacity increases, it will be useful information for those thinking that running should run fast.

Methods

Subjects

Seventeen elderly subjects participated in this study. The subject characteristics are shown in (Table 1). Subjects were chosen from members of fitness club with hospital. The subject exercises such as bicycle ergo meter, walking, bench stepping, strength training 2-3 times a week. They are used to these exercises, but not familiar with jogging. The subject has either or both hypertension and dyslipidemia. The purpose, procedures, and risks of the study were explained to each participant and all gave their written informed consent before participating in the study. The Ethics Committee of Fukuoka University (Fukuoka, Japan) approved the study.

Age yr	71.0±5.2
Ht cm	154.4±7.6
BM kg	56.7±8.0
BMI kg/m ²	23.8±2.7
m/f	3/14

Values are means ± SD; Ht; height; BM, body mass BMI, body mass index; m/f, ratio of male to female

Study design

The following three measurements were performed randomly. 1) Progressive running test for lactate threshold, 2) Test of preferred transition speed, and 3) Outdoor test of running at pace with a smile. Each test was conducted on a separate day. The subject avoided severe exercise from the day before the measurement day, and refrained from taking meals and caffeine 4 hours before the start of the experiment.

Progressive running test

Progressive protocols of running were carried out, starting at a treadmill (Senoh X Laborido 2200, Chiba, Japan) speed of 2km/h. The speed was increased by 1km/h per 3 minutes. It was increased by 0.5 km / h depending on the condition of the subject. The heart rate was measured 5-6 times starting at 2:30 min mark and averaged. Polar HR monitor (Polar FT1, Kempele, Finland) was used. RPE was enquired once at each stage, between 2:30~2:45 min marks. Blood samples were obtained to measure the blood lactate concentration just after each stage. The treadmill was paused for blood sampling for around 1 min between stages. Tests were terminated when the subject's blood lactate concentration reached 3 mM, or when the exercise could not be performed at a constant speed. Subjects were instructed to report their perceived exertion according to the Borg 6-20 RPE scale [9]. The LT was determined by the following method.

Determination of Lactate Threshold

Blood samples were obtained from the earlobe, and evaluated using a lactate analyzer (Arkray Lactate Pro 2, Kyoto, Japan). The speed at the first breaking point of the blood lactate level was used to determine the LT, and five trained staff members visually checked the results using log-log (speed-lactic acid levels) graph

paper, and after excluding the minimal and maximal value the mean value from three members out of the five members was taken [22].

Test of Preferred Transition Speed

This study defined PTS as averaged speed between Walk-Run Transition Speed (Walk-Run TS) and Run-Walk Transition Speed (Run-Walk TS). Subjects started walking from the speed of 3km/h, and increased it by 0.2km/h every 10 seconds. Once subjects started running, he/she walked again to confirm which gaits were more comfortable. If feeling running more comfortable than walking, the speed was defined as Walk-Run TS. Conversely, Run-Walk TS was started running from the speed of about 1.0km/h faster than Walk-Run TS. Similar procedure like Walk-Run TS was conducted to determine Run-Walk TS relying on comfortableness. This test was carried out twice with a 10 minute interval in between, and the average value was taken as a representative value.

Outdoor Test of Running at Pace with a Smile

The place we tested was a park where walking is possible, or on a road with few passengers. The road surface was asphalt or interlocking concrete and almost horizontal. Running was done back and forth in order to avoid the influence of possible wind and slight inclination. We asked the subject to run with images that is able to keep a smile with nature, and to talk with the next person (RPS). Simultaneously, the subject was shown a table of Borg's RPE scale and asked to run in the "fairly light" range of 10 to 12. If it became 13 "somewhat hard" or 9 "very light", subject controlled the running speed with the next set. 10 sets of running for 1 minute were performed, and the averaged last two sets were adopted. Distance was measured in order to calculate the speed.

Statistical Analysis

The data are expressed as the mean ± SD. comparing each gait speed (Run-LT, PTS and RPS), Student's T-test (pair-wise T test) was used for comparison between speeds. The regression line of each subject was determined from the running speed (x) and RPE (y) at each stage during the load test. From this regression line, RPE at LT, PTS and RPS was estimated. The statistical analyses were performed using SPSS version 18.0 software package (IBM SPSS Inc., ArmonkNY, USA). Statistical significance was set as p=0.05.

Results

(Table 2) shows LT, PTS and RPS, respectively, with LT of 4.8 ±0.8 km / h, PTS of 5.9 ± km / h, and RPS of 6.6 ±0.5 km/h. RPS was significantly higher than LT (p <0.01), and all subjects surpassed LT (Fig. 1). LT was also significantly lower than PTS (p <0.01,) and was the speed in the range of walking (Fig. 2). On the other hand, as shown in, RPS was significantly higher than PTS (P <0.01) (Fig. 3). That is, even though LT was Preferred Walking Speed, RPS ran at Preferred Running Speed.

(Table 3) shows estimated blood lactate concentrations at RPS. If 4 mM or more is defined as high intensity exercise, 4 out of 17 subjects became high intensity exercise exceeding 4 mM.

Table 2: Gait Speeds

LT	4.8±0.8
PTS	5.9±0.7 #
RPS	6.6±0.5 #§

Values are means ± SD. LT, lactate Threshold in running; PTS, preferred transition speed; RPS, running; PTS, preferred transition speed; RPS, running at pace with a smile. # Significantly different from LT, P<0.01. § Significantly different from PTS, P<0.01

Table 3: Comparison of the speed at LT and RPS, and blood lactate concentrations in individual subjects.

	speed at LT	speed at RPS	BLC at RPS
1	5.7	6.7	1.6
2	4.5	6.6	4.0
3	4.5	6.4	2.5
4	5.0	6.2	3.0
5	4.4	6.3	3.0
6	4.3	6.4	1.9
7	4.5	7.9	5.0 #
8	6.0	6.9	1.8
9	4.6	6.9	4.4 #
10	5.5	6.9	2.0
11	4.2	5.8	4.8 #
12	4.5	6.7	2.3
13	4.0	6.2	1.8
14	5.0	6.4	2.5
15	4.5	6.9	4.1 #
16	4.0	5.4	2.5
17	7.0	7.0	2.1
Mean	4.8	6.6	2.9
SD	0.8	0.5	1.1

BLC, blood lactate concentration; # Represents a Subject exceeding 4mM

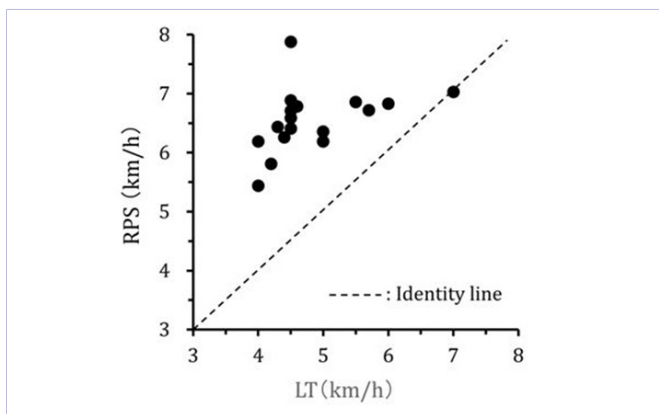


Figure 1: Relationship between lactate threshold in running (LT) and running at pace with a smile (RPS).

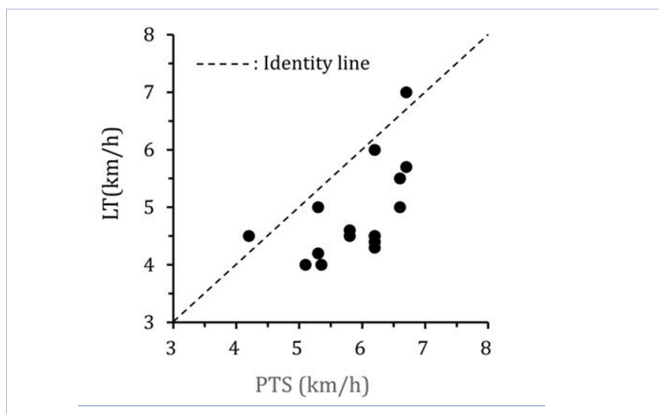


Figure 2: Relationship between preferred transition speed (PTS) and lactate threshold in running (LT)

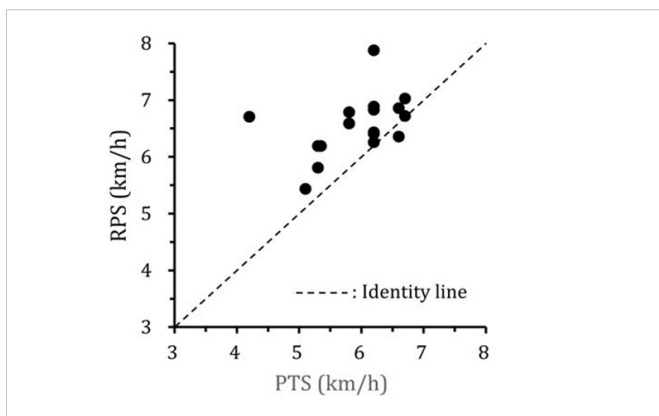


Figure 3: Relationship between preferred transition speed (PTS) and running at pace with a smile (RPS).

Discussion

The major finding of this study was that running at pace with a smile, relying on rating of perceived exertion, easily exceeds lactate threshold (LT) intensity in elderly people. We demonstrated in our numerous studies that training at LT intensity was effective for improving health problems in terms of exercise therapy [2-5]. Also, in terms of culturing fitness level, exceeding LT intensity was of great importance because it was considered to be a minimal intensity required to increase aerobic power [1]. Additionally, by measuring PTS, even if LT intensity was below PTS, most of the elderly subjects ran above PTS while keeping 10-12 of RPE or "Pace with a Smile".

We conducted three experiment of RPS, LT measurement and PTS to confirm whether RPS exceeds LT intensity or not in random order. In the relation between RPS and LT intensity, the speeds in RPS and LT were 6.6±0.5km/h and 4.8±0.8km/h, respectively. RPS was significantly faster than Run-LT by 1.8km/h (p<0.001). From the individual regression line, RPE at LT was estimated 11.9±1.8, which varied considerably by individual. Range of the RPE values was 9.0 (minimum) and 15.3 (maximum). In light of these data, subjects with RPE at LT being close to the maximum (about 15) should have under an the LT speed when running at pace with a smile. However, all of the elderly subjects exceed LT intensity with 10-12 of RPE kept. These findings were similar to the previous studies [20,21] indicating that, when prescribing

exercise intensity based on RPE from the laboratory test, the speed in an outdoor setting was faster than that on a laboratory treadmill. Oxygen consumption of level running is similar for both treadmill and outdoor running [23,24]. Therefore, the difference of running environment may have affected the running speed, resulting in over speed compared to laboratory treadmill test. However, our experimental design of this study was randomized order, not referring to the RPE from a graded test. Thus, we speculated that exceeding LT in this study was responsible for other factors such as degrees of RPE in running itself, PTS and 1 minute duration of RPS.

We have demonstrated that RPE was lower in running than in walking at the same heart rate and blood lactate concentrations in young adults [14]. Even at the heart rate of 150 and blood lactate concentration of 2 mM the RPEs for running were only 12.8 ± 1.3 and 12.6 ± 1.1 , respectively, which means that it can be relatively easy to exceed LT intensity. Therefore, running itself tended to hard to feel even if heart rate or blood lactate concentration rose, resulting in increasing running speed. However, in this regard further research will be needed to confirm whether even elderly people are hard to feel in running.

Since PTS in this study was 5.9km/h, LT intensity (4.8km/h) in elderly people was nearly walking speed. Regardless of this result, RPS exceeds PTS, which means running within the range of Preferred Running Speed. RPE at PTS was estimated 13.9 ± 2.0 from the individual regression line. This RPE, close to "somewhat hard", was significantly higher than RPE at LT. Furthermore, RPE at 6.6km/h in RPS was estimated 15.0 ± 2.1 from the same equation, and this speed should have caused feeling "hard". But, to reconfirm RPE after 10 sets of 1 min RPS test, elderly subjects reported "fairly light" or 11, the same as RPS definition "pace with a smile". This may be because short running duration was adopted in this study. Heart rates (HR) as well as blood lactate concentrations (BLC) were expected to be not reached steady state by 1 minute. Previous study demonstrated that 3-4 min is needed to reach steady state in HR and BLC [25]. Therefore, we speculated that, stopping running before reaching steady state of HR and accumulation of blood lactate may have exceeded PTS, resulting in exceeding LT intensity.

compared PTS between runners and non-runners [16]. They concluded that PTS was not affected by aerobic capacity because no significant difference was found between both PTS (7.23 ± 0.25 vs. 7.42 ± 0.25). According to the other study on PTS for obese and overweight subjects, PTS was 5.97 ± 0.03 and 6.19 ± 0.41 , respectively [17]. The PTS in this study was nearly the same speed as obese people. The PTS was 5.9 km/h, which was higher than expected, and PTS was not so low even for elderly people. At the time of the RPS test, it may be over the speed which it is supposed to start running naturally (PTS), possibly exceeding LT.

There were some subjects, who largely exceeded LT intensity. We estimated lactate concentration in RPS by extrapolation from intersection between running speed and lactate concentration. We defined more than 4mM of lactate concentration as high intensity

exercise. Consequently, in 4 subjects out of 17 (23.5%) the RPS became high intensity exercise following this definition. As is the case in aforementioned studies [16, 17], if PTS occurred around 6km/h, and RPS exceeding PTS, regardless of age, fitness level and physical constitution, it can become high intensity exercise more than 70% Vo₂max for elderly people, e.g. 2.9km/h (3.8 ± 0.5 METs) at LT in our previous study [6] In other words, these data suggested that jogging purposely below PTS (at walking speed) would be safe and effective for elderly people.

A number of studies on the prevention of lifestyle-related diseases have been reported that increasing physical activity and exercise contribute to prevent their onset [26-29]. In such a background, we have recently recommended jogging, especially intermittent slow jogging. Until now, in our intervention study, after the graded test, we decided exercise intensity of each individual subject, promoted the exercise in the controlled classroom, and promoted to continue jogging by them (home-based exercise). As a results, intermittent slow jogging reported increase in muscle hypertrophy and leg strength of the thigh [8], increase in walking speed, improvement in lipid metabolism [4], normalization of postprandial blood glucose level by exercise [7]. If intermittent slow jogging of repetitive 1 minute, it is possible enough for exercise beginners to start exercise without resistance. As stated above, when maintaining constant intensity exercise, the oxygen uptake to be steady state takes more than 4 minutes [25]. Even if exercise of high intensity is done for one minute, it ends before reaching the steady state, so it will be a preventive measure to increase the cardiac metabolic stress. However, with this regard, further study is needed to conduct measurements on 1 minute and 4 minutes after exercise by using double product of heart rate and the amplitude of the first heart sound (DP-AHS1) which can evaluate cardiac metabolic stress [30] to what extent the high intensity is acceptable.

The limitation of this study was that, as already discussed, jogging prescribed at "Pace with a Smile or RPE 10-12" exceeded LT, but it also included the possibility of becoming high intensity exercise. Investigated the validity of RPE in patients with type 2 diabetes mellitus (DM) [31]. According to the study, RPE gauged exercise intensity in approximately half of the overweight patients with type 2 DM, but one third was at the risk of exercising at a higher intensity exceeding the appropriate range. Likewise, even in this study, 4 elderly people out of 17 became high intensity exercise despite LT being 4.8 km/h. In our previous study the elderly had an LT of 2.9 km/h, which reported low fitness [6]. Therefore, RPS may exceed the PTS and become a high intensity exercise only with the instruction "Pace with a Smile" for elderly people, those with low fitness, and the people suffering from chronic diseases. In other words, the present data suggests that the prescription of "running below PTS (at walking speed)" is effective for achieving optimal exercise intensity in addition to "Pace with a Smile" for those with such characteristics. As another study limitation, this method is considered difficult for those who are not familiar with RPE itself, those who try hard. Further research on personal characteristics is also necessary.

Conclusion

In conclusion, it was shown that Running at "Pace with a Smile" readily exceeded LT intensity. However, there were 4 subjects exceeding 4 mM of blood lactate concentration. Therefore, as a hint of exercise prescription for the elderly, it was suggested that running at walking speed, that is, slow jogging can be recommended to avoid becoming high intensity exercise.

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