



## Heart Rate, Accelerometer Measurements, Experience and Rating of Perceived Exertion in Zumba, Interval Running, Spinning, and Pyramid Running

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### ABSTRACT

**Hausken K, Dyrstad SM.** Heart Rate, Accelerometer Measurements, Experience, and Rating of Perceived Exertion in Zumba, Interval Running, Spinning, and Pyramid Running. **JEPonline** 2013;16(6):39-50. This study investigated the relationship between heart rate (HR), accelerometer measurements, experience, and rating of perceived exertion (RPE) in Zumba, interval running, spinning, and pyramid running. Thirty-five subjects (22 females) participated in this study. Percent of maximum HR (%HR max) was determined by Polar HR monitors, accelerometer counts by ActiGraph GT3X, energy expenditure (EE) by the Hiilloskorpi et al. method, experience by a questionnaire, and RPE by Borg's method. In Zumba, but not in interval running or spinning, the more experienced subjects reported a higher RPE than the less experienced subjects. They also exercised at a higher %HR max, and they produced a higher number of accelerometer counts. Zumba is the only exercise session where the subjects had a significant correlation of 0.5-0.6 between RPE and %HR max, accelerometer counts, and EE. Zumba was perceived 18.8 to 23.3% less exhaustive than the other 3 sessions ( $P < 0.0001$ ). Zumba is considered more technical than running and spinning, thus the inexperienced Zumba subjects exercised at a lower %HR max. If the goal is maximum calories burned or maximum aerobic fitness, then, beginners should choose simpler exercises such as running or spinning.

**Key Words:** Zumba, Running, Spinning, RPE

## INTRODUCTION

Objective measurements of exercise intensity expressed as a percentage of maximum heart rate (%HR max), accelerometer counts, and energy expenditure (EE) for Zumba, interval 4x4 min running, 4x4 min spinning, and pyramid running are largely unknown. Linking these insights into experience and rating of perceived exertion (RPE) is also unknown.

Zumba is a Latin dance-inspired fitness program designed by Alberto "Beto" Perez during the 1990s (18). Zumba was chosen because it represents a new popular exercise form that has hardly been analyzed earlier. Two available reports are Luettggen and colleagues (19) and Sanders and Prouty (23). Interval running and spinning were chosen because of their commonality. Accelerometers were chosen because they have become increasingly popular and need to be tested against HR monitors.

Thus, this study analyzed %HR max, accelerometer counts, experience, and RPE in Zumba, 4x4 running, 4x4 spinning, and pyramid running. A key focus was the subjects' self-monitoring based on perception or target HR. After each training session, the subjects filled out a questionnaire specifying their RPE and prior experience with the training form. This enabled comparing %HR max, accelerometer counts, and EE with experience and RPE. A widely used and validated tool to assess subjective perception of effort during exercise is Borg's RPE scale (4). For validation references, refer to Chen and colleagues (5) and Scherr et al. (24). To our knowledge, Borg's RPE scale has not been analyzed in conjunction with "experience" in different exercise sessions in healthy subjects.

In earlier research, HR and EE have been determined for weight lifting, step aerobics, and similar activities (1-3,8,15-17,22,25). Hausken and Tomasgaard (12) analyzed interval training with various training forms joined sequentially. Helgerud et al. (13) considered the effect of four different running programs on maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ) and stroke volume. Crouter and colleagues (6), Crouter et al. (7), Freedson et al. (9), Hartel (11), and Lyden et al. (20) carried out the earlier research on accelerometers. Thus, the following rationale underlying the research hypotheses was analyzed.

- The rationale for Hypothesis 1 (Experienced and inexperienced subjects have the same %HR max, accelerometer counts, and energy expenditures) was to determine whether the experienced subjects versus the inexperienced subjects in the four sessions would have different %HR max, accelerometer counts, and EE. An experienced subject was identified as someone who has experienced a session at least eight times.
- The rationale for Hypothesis 2 (Subjects having experienced a session one time and more than one time have the same %HR max, accelerometer counts, and energy expenditures) was that the distinction between the experienced subject and the inexperienced subject needs to be supplemented with a distinction between subjects having experienced a session one time and more than one time.
- The rationale for Hypothesis 3 (RPE correlates with %HR max, accelerometer counts, and energy expenditures for all subjects) was the need to determine whether RPE correlates with %HR max, accelerometer counts, and energy expenditures across the four sessions.
- The rationale for Hypothesis 4 (No differences in RPE exist between the four exercise types) was driven by the need to determine the differences in RPE across the four exercise types.

## METHODS

### Subjects

Thirty-five volunteers (22 females) with individual data shown in Table 1 were included in this study. They were recruited from students in the academic sports sciences programs. Twenty six subjects (15 females) completed the four exercise sessions. All subjects gave written informed consent. It was concluded that the study, which is observational of one physiological variable (HR) did not require formal IRB approval (although it was approved by the Norwegian Ethics Committee and the Norwegian Social Science Data Services AS).

**Table 1. Subjects' Characteristics with Heart Rate Maximal (HR max) in Bed in the Morning (rest) and during the Day Sitting (HR<sub>sit</sub>).** Experience ranged from 1 to 8, where 1 means it was their first time and 8 means they had participated in the exercise 8 times or more. Rating of perceived exertion (RPE) ranged from 6 (no exertion) to 20 (maximal exertion).

ID	Age (yrs)	Body mass (kg)	Height (cm)	Gender	HR max	Zumba experience	Zumba RPE	4x4 running experience	4x4 running RPE	4x4 spinning experience	4x4 spinning RPE	Pyramid running experience	Pyramid running RPE
1	20	78.0	183	M	205			8	15				
2	21	59.0	165	F	202	1	14			2	17	8	15
3	20	55.3	165	F	200	1	12	8	16	4	17	8	17
5	20	70.5	165	F	199	7	14	8	18	8	18		
6	22	59.3	165	F	208	2	15	6	15	8	16	6	17
7	23	62.5	162	F	202	8	14						
8	23	52.8	161	F	200	2	13	8	16	8	16	8	16
9	20	77.4	180	M	195	1	9						
11	19	63.4	164	F	190	1	12	8	17	1	18	8	19
12	21	80.1	181	M	208	5	14	8	18	8	18	8	17
13	26	60.7	174	F	196	4	15	8	15	8	17	1	16
14	19	73.8	185	M	201	1	15	6	16	1	18	1	16
15	23	61.5	167	F	195	2	13	4	16	1	19	2	16
16	20	87.6	190	M	197	1	10	8	17	2	18	1	17
17	22	59.5	164	F	200	1	13	6	15	6	17	1	18
18	26	77.5	177	M	202	2	15	8	18	2	18	1	19
19	21	77.4	176	M	197	1	13	8	17	8	18	8	17
20	20	56.5	158	F	208	1	12	8	15	8	17	8	16
21	21	59.3	158	F	193	4	13	4	15			4	15
22	21	72.0	170	M	196	1	13	8	16	8	17	8	17
25	22	54.5	166	F	200	6	13	5	17	8	18	3	17
27	19	48	154	F	194	1	13	8	16	8	17	2	17
28	27	71.5	186	M	194	1	16	8	17	2	17	8	17
29	23	60.5	176	F	193	1	9	8	14	1	15	8	14
30	20	68.9	177	M	173	2	14	8	17	2	18	2	17
31	19	59.2	150	F	194	8	14	8	17	1	17	1	18
32	21	62.7	160	M	186	8	20	8	16	1	18	1	17
33	27	53.9	172	F	180	5	13	8	17	8	19	8	18
34	19	54.6	167	F	198	8	13	6	16			1	17
35	20	61.1	167	F	207	2	13	8	17				
37	21	58.0	164	F	193	1	12	8	17	8	19	8	13
38	20	63.0	175	M	204	1	13	8	17	8	16	8	18
39	22	59.5	163	F	195	8	14	4	16	8	17	3	18
40	23	72.9	187	M	208	1	14	5	17	2	17	8	17
41	21	72.0	175	F	195	3	11			8	14		
M	21.5	64.7	170		197.4	3.0	13.26	7.2	16.32	5.1	17.28	4.9	16.76
SD	2.2	10.3	9.8		7.6	2.6	1.97	1.4	1.01	3.2	1.13	3.2	1.33

<sup>a</sup>HR<sub>rest</sub> estimated to 48 beats·min<sup>-1</sup>, i.e., mean difference between HR<sub>sit</sub> and HR<sub>rest</sub> for all subjects was subtracted from HR<sub>sit</sub>.

## **Procedures**

### ***Experimental Approach to the Problem***

Four exercise sessions were carried out by 35 subjects at the SIS Sports Center at the University of Stavanger, Norway: (a) Zumba, January 16, 2012 at 18:00-19:00; (b) 4x4 running, January 19, 2012 at 15:15-16:00; (c) 4x4 spinning, January 23, 2012 at 15:15-16:00; and (d) pyramid running, January 26, 2012 at 15:15-16:00. All subjects were well nourished and consumed water during each session. The temperature was around 22°C with a humidity of 45%. For Zumba, the subjects were told to follow the instructor's instructions with no target HRs. For the three other sessions, the subjects knew their max HR, and followed the instructor's comments through the intervals to adjust to 70% and 90 to 95% of max HR.

### ***Zumba (60 min)***

A warm-up song was followed with Zumba and a cool-down song at the end.

### ***4x4 Running (45 min)***

A 12-min warm-up was followed by a 4-min running period at 90 to 95% of the subjects' max HR and, then, 3 min jogging period at 70% of max HR, four times, for a total of 28 min and, finally, a 5-min cool-down.

### ***4x4 Spinning (45 min)***

The same procedure was followed as in the 4x4 running except that running and jogging were replaced with spinning.

### ***Pyramid Running (45 min)***

A 12-min warm-up was followed by a 6-min running period at 90 to 95% of max HR and 1-min jogging at 70% of max HR, then, 5 min of running and 1 min of jogging, 4 min of running and 1 min of jogging, 3 min of running and 1 min of jogging, 2 min of running and 1 min of jogging, 1 min of running and 1 min of jogging and, finally, 1-min of running and 5 min of cool-down.

## ***Measurements***

### **Heart Rate**

The subjects' HR was measured every 5 sec using Polar Team II HR belt and RS 100 monitor (Polar Electro Oy, Kempele, Finland). Body mass was measured using a calibrated, digital scale (Seca model 770, Seca GmbH and Company, Hamburg, Germany). The subjects' measured their maximal HR indoor or outdoor by the following procedure: (a) 20 min with increasing running intensities followed by 5 min of stretching; and (b) two uphill running intervals (5% incline at treadmill) lasting 3 min. The first interval was expected to be hard, but not to the point of exertion. Then, a 3-min active break was followed by a running interval to exertion. The session ended with a 15-min cool-down run. The highest registered HR was set as maximal HR (HR max).

### **Accelerometer**

The ActiGraph GT3X (ActiGraph, LLC, Pensacola, FL, USA) was used to measure the subjects' accelerometer counts. The accelerometers were initialized and downloaded using the ActiLife 6 software provided by the manufacturer (ActiGraph LLC). The data were collected in 60-sec epochs. Tri-axial vector magnitude (VM) was used.

### **Experience and RPE**

Hypotheses 1 and 2 distinguished subjects with little and much experience with two interpretations because of the variation in experience prior to the sessions (Table 1). The subjects were first identified as one time experience and, then, more than one time and, then, thereafter with experience less than 8 times or  $\geq 8$  times. Borg's (4) 15-point RPE scale was used during the sessions ranging from 6 (20% effort) to 20 (100% effort). One RPE point was considered  $\sim 10 \text{ beats} \cdot \text{min}^{-1}$ . This was explained and illustrated for the subjects (refer to Table 1). The Borg's RPE method is strongly correlated with HR (24).

### **Statistical Analyses**

Energy expenditure (EE) was determined by using the model 2 equation (p. 441) of Hiilloskorpi et al. (14), where  $\times$  means multiplication, HR is heart rate, body mass is measured in kg, and gender is 0 for women and 1 for men.

$$\begin{aligned} EE = & -1.68 + 10.84 \times \text{gender} + HR (0.043 - 0.106 \times \text{gender}) \\ & - \text{mass} (0.105 + 0.101 \times \text{Gender} + \text{age} (0.095 - 0.107 \\ & \times \text{gender}) + HR \times \text{mass} (0.00134 + 0.00119 \times \text{gender}) \\ & - HR \times \text{age} (0.0011 - 0.00110 \times \text{gender}) \end{aligned}$$

To measure differences between the two groups' mean HR, accelerometer counts, and EE in the four training sessions (Hypothesis 2 for Zumba and Hypothesis 1 for 4x4 spinning and pyramid running), an independent Sample *t*-test was used. To test the same differences in the other tests of Hypotheses 1 and 2, the Mann-Whitney U-test was used since the sample size in one of the groups was  $<10$ . This test was also used to study the difference between the men and the women.

To study the correlations between RPE and HR, accelerometer counts and EE (Hypothesis 3), the Spearman's rho ( $\rho$ ) correlation coefficient was used. To test Hypothesis 4, the related samples Wilcoxon Signed Rank Test was used (given that it is suitable for the RPE ordinal data). The data are presented as means  $\pm$  standard deviation (Mean  $\pm$  SD). Statistical significance was set at  $P \leq 0.05$ . All statistical analyses were performed using PASW Statistics 18 for Windows (IBM Corporation, Route, Somers, NY, USA).

## **RESULTS**

Table 2 shows the results for Hypotheses 1 and 2 while Table 3 presents the results for Hypothesis 3. Table 4 shows the statistical findings for Hypothesis 4 (the percentage differences in RPE between the four exercise types measured by Borg's scale).

**Table 2. Results for Hypotheses (H) 1 and 2.** Mean  $\pm$  SD and differences in %HR max, accelerometer (acc) counts, and energy expenditure (exp) between subjects with much and little experiences. The % difference is between much (as a reference) and little experience, and is negative when the values for little experience is lowest. Much experience means more than one time, or eight times or more as specified in each hypothesis. Little experience means one time or less than eight times as specified in each hypothesis. The column  $n_m$  expresses the number of subjects with much experience. The HR monitor did not work for ID7 during Zumba causing  $n = 33$  in rows 1,3,4,6,  $n_m = 4$  in rows 1 and 3, and  $n_m = 17$  in rows 4 and 6. Accelerometer counts are measured in counts $\cdot$ min $^{-1}$ . Energy expenditures are measured in kcal $\cdot$ min $^{-1}$ . All subjects have experienced 4x4 running at least four times.

	All Subjects					Males					Females				
	Much experience Mean $\pm$ SD	$n_m$	% diff	p	Total n	Much experience Mean $\pm$ SD	$n_m$	% diff	p	Total n	Much experience Mean $\pm$ SD	$n_m$	% diff	p	Total n
H 1 Zumba %HR max	84.8 $\pm$ 6.3	4	-13.3	0.030*	33	87.1	1	-16.4	0.17	12	84.1 $\pm$ 7.5	3	-16.8	0.12	21
H 1 Zumba acc counts	7883 $\pm$ 1612	5	-19.4	0.056	34	10426	1	-38.5	0.17	12	7247 $\pm$ 876	4	-12.8	0.26	22
H 1 Zumba energy exp	10.63 $\pm$ 1.32	4	-8.7	0.377	33	11.49	1	0.7	1.00	12	10.35 $\pm$ 1.46	3	-17.2	0.15	21
H 2 Zumba %HR max	79.0 $\pm$ 9.0	17	-10.6	0.015*	33	78.9 $\pm$ 7.4	4	-9.2	0.21	12	79.0 $\pm$ 9.7	13	-11.8	0.076	21
H 2 Zumba acc counts	7011 $\pm$ 1285	18	-13.1	0.047*	34	7470 $\pm$ 2154	4	-14.6	0.46	12	6878 $\pm$ 937	14	-12.8	0.095	21
H 2 Zumba energy exp	10.15 $\pm$ 2.33	17	-6.7	0.45	33	12.10 $\pm$ 2.05	4	-6.6	0.81	12	9.55 $\pm$ 2.13	13	-20.2	0.12	21
H 1 4x4 Spinning %HR max	80.5 $\pm$ 3.8	15	-0.3	0.83	29	80.3 $\pm$ 1.2	4	1.2	0.79	11	80.7 $\pm$ 4.4	11	-1.6	0.66	18
H 1 4x4 Spinning acc counts	4970 $\pm$ 1375	15	-6.5	0.47		4461 $\pm$ 1647	4	7.0	0.79	11	5155 $\pm$ 1300	11	-12.2	0.33	18
H 1 4x4 Spinning energy exp	10.77 $\pm$ 2.23	15	5.8	0.47		13.57 $\pm$ 1.78	4	-2.9	0.79	11	9.74 $\pm$ 1.32	11	-1.6	0.48	18
H 2 4x4 Spinning %HR max	80.6 $\pm$ 3.4	23	-0.9	0.69	29	80.6 $\pm$ 2.4	9	1.9	0.22	11	80.6 $\pm$ 3.9	14	-2.3	0.80	18
H 2 4x4 Spinning acc counts	4984 $\pm$ 1174	23	-13.1	0.28		4584 $\pm$ 1175	9	8.9	0.91	11	5183 $\pm$ 1154	14	-23.7	0.19	18
H 2 4x4 Spinning energy exp	11.25 $\pm$ 2.28	23	-7.8	0.36		13.53 $\pm$ 1.58	9	-8.3	0.58	11	9.78 $\pm$ 1.17	14	-4.6	0.38	18
H 1 4x4 Running %HRmax	82.2 $\pm$ 3.6	22	1.6	0.43	31	81.5 $\pm$ 3.6	10	-2.6	0.48	12	82.7 $\pm$ 3.6	12	-2.3	0.34	19
H 1 4x4 Running acc counts	8387 $\pm$ 842	22	-4.0	0.17		9236 $\pm$ 862	10	4.4	0.36	12	7680 $\pm$ 2161	12	-1.1	0.26	19
H 1 4x4 Running energy exp	11.63 $\pm$ 2.40	22	-2.8	0.98		13.49 $\pm$ 2.08	10	1.5	0.61	12	10.09 $\pm$ 1.32	12	5.4	0.26	19
H 1 Pyramid running %HR max	84.8 $\pm$ 3.0	14	-3.1	0.025*	29	82.2 $\pm$ 1.5	6	1.2	0.33	11	82.3 $\pm$ 3.5	8	4.0	0.12	18
H 1 Pyramid running acc counts	8460 $\pm$ 1405	14	-2.9	0.60		9011 $\pm$ 1119	6	0.9	0.93	11	8047 $\pm$ 845	8	-3.4	0.57	18
H 1 Pyramid running energy exp	11.60 $\pm$ 2.50	14	0.0	0.99		13.96 $\pm$ 1.67	6	-2.6	0.79	11	9.82 $\pm$ 1.10	8	7.9	0.17	18
H 2 Pyramid running %HRmax	83.7 $\pm$ 3.4	21	-0.6	0.94	29	82.4 $\pm$ 1.5	7	0.7	0.53	11	84.3 $\pm$ 3.9	14	-1.2	0.65	18
H 2 Pyramid running acc counts	8127 $\pm$ 1094	21	9.2	0.20		8858 $\pm$ 1098	7	5.9	0.53	11	7761 $\pm$ 922	14	7.9	0.44	18
H 2 Pyramid running energy exp	11.34 $\pm$ 2.08	21	8.2	0.46		13.52 $\pm$ 1.92	7	5.6	0.65	11	10.25 $\pm$ 1.07	14	0.1	0.95	18

\*Significant at  $P < 0.05$ ; % diff = % difference

**Table 3. Results for Hypothesis 3.** Spearman correlation ( $\rho$ ) between perceived exertion and the physiological measurements, significance (P), and number (n) of subjects.

	All Participants			Men			Women		
	( $\rho$ )	p	n	( $\rho$ )	p	n	( $\rho$ )	p	n
Zumba %HR max	0.57	0.001*	33	0.42	0.17	12	0.77	0.001*	21
Zumba accelerometer counts	0.59	<0.0001*	34	0.49	0.11	12	0.66	0.001*	22
Zumba energy expenditure	0.53	0.002*	33	0.19	0.56	12	0.71	0.001*	21
4x4 Spinning %HR max	0.42	0.023*	29	0.54	0.08	11	0.40	0.098	18
4x4 Spinning accelerometer counts	-0.15	0.44	29	0.11	0.76	11	-0.20	0.43	18
4x4 Spinning energy expenditure	0.18	0.36	29	0.38	0.24	11	-0.09	0.73	18
4x4 Running %HR max	-0.04	0.81	31	0.24	0.45	12	0.02	0.93	19
4x4 Running accelerometer counts	0.43	0.017*	31	0.31	0.32	12	0.21	0.38	19
4x4 Running energy expenditure	0.30	0.097	31	0.45	0.14	12	-0.03	0.90	19
Pyramid running %HR max	0.01	0.97	29	-0.47	0.14	11	0.15	0.56	18
Pyramid running accelerometer counts	0.05	0.81	29	0.11	0.75	11	-0.16	0.53	18
Pyramid running energy expenditure	0.11	0.57	29	-0.03	0.93	11	-0.11	0.67	18

\*Significant at  $P < 0.05$

**Table 4. Percentage Differences in Rating of Perceived Exertion (RPE) in the Column Session Compared with the Row Session and Significance (n = 26).** Negative percentages mean that the column session is perceived to be less exhaustive than the row session and, conversely for positive percentages. The three percentages in each cell are for all subjects (males and females), respectively.

	Zumba	4x4 Running	4x4 Spinning	Pyramid running
Zumba		23.1 <sup>a</sup> , 21.1 <sup>f</sup> , 23.9 <sup>a</sup>	30.3 <sup>a</sup> , 26.9 <sup>l</sup> , 32.1 <sup>a</sup>	26.4 <sup>a</sup> , 24.2 <sup>i</sup> , 27.4 <sup>a</sup>
4x4 Running	-18.8 <sup>a</sup> , -17.4 <sup>f</sup> , -19.3 <sup>a</sup>		5.9 <sup>a</sup> , 4.8 <sup>d</sup> , 6.6 <sup>e</sup>	2.7 <sup>b</sup> , 2.6 <sup>g</sup> , 2.8 <sup>h</sup>
4x4 Spinning	-23.3 <sup>a</sup> , -21.2 <sup>l</sup> , -24.3 <sup>a</sup>	-5.6 <sup>a</sup> , -4.6 <sup>d</sup> , -6.2 <sup>e</sup>		3.0 <sup>c</sup> , -2.1 <sup>j</sup> , -3.6 <sup>k</sup>
Pyramid running	-20.9 <sup>a</sup> , -19.5 <sup>i</sup> , -21.5 <sup>a</sup>	-2.6 <sup>b</sup> , -2.5 <sup>g</sup> , -2.7 <sup>h</sup>	3.1 <sup>c</sup> , 2.2 <sup>j</sup> , 3.7 <sup>k</sup>	

<sup>a</sup> $P < 0.0001$ , <sup>b</sup> $P < 0.01$ , <sup>c</sup> $P = 0.088$ , <sup>d</sup> $P = 0.053$ , <sup>e</sup> $P = 0.001$ , <sup>f</sup> $P = 0.028$ , <sup>g</sup> $P = 0.18$ , <sup>h</sup> $P = 0.03$ , <sup>i</sup> $P = 0.011$ , <sup>j</sup> $P = 0.305$ , <sup>k</sup> $P = 0.185$ , <sup>l</sup> $P = 0.006$

The mean RPE was significantly different ( $P < 0.05$ ) between all exercise type, except between pyramid running and spinning ( $P = 0.088$ ). The largest difference was found between Zumba and spinning where the subjects reported 29.1% higher RPE in spinning compared to Zumba. Table 4 shows the difference in RPE in the column session compared with the row session.

Men and women participating in Zumba for the first time ( $n = 16$ ) reported an RPE of  $12.5 \pm 1.9$ , which was 10.3% lower than the subjects who had tried Zumba earlier ( $n = 18$ ;  $P = 0.031$ ). No difference in RPE was found between experienced and inexperienced subjects in the other training sessions.

When dividing the subjects into men and women, Table 2 for Hypotheses 1 and 2 showed no significant differences in %HR max, accelerometer counts, and energy expenditure between the experienced and the inexperienced participants. When splitting men and women, the Spearman correlation ( $\rho$ ) in Table 3 for Hypothesis 3 for women in Zumba between perceived exertion and %HR max, accelerometer counts, and energy expenditure was 0.77, 0.66, and 0.71, respectively ( $P < 0.001$ ,  $n = 21$ ). No significant correlations were found for the men in Zumba and for the women in the other exercise sessions. Table 4 for men and women confirmed the results for all subjects.

## DISCUSSION

This study found that Zumba was 20 to 30% less exhaustive than running and spinning. Two reasons that support this finding are: (a) the nature of Zumba, which is not especially exhaustive; and (b) the instructor's guidance, which (once again) is not designed for high intensity. Inexperienced Zumba subjects in the present study exercised at a lower %HR max. They also produced less accelerometer counts while no such differences were found in 4x4 running and 4x4 spinning.

The rejection of Hypothesis 1 for Zumba means that the experienced subjects obtained larger %HR max and accelerometer counts than the inexperienced subjects. The large percentages express quite different impact of training for the two kinds of subjects. Interestingly, while the difference was significant ( $P = 0.030$ ) for %HR max, it was just slightly below the 5% significance level ( $P = 0.056$ ) for accelerometer counts due to the low numbers  $n_m = 4$  and  $n_m = 5$  of subjects with much experience.

The rejection of Hypothesis 2 for Zumba, which compared the subjects having experienced Zumba one time and more than one time, resulted in a smaller % difference than for Hypothesis 1 for Zumba. But, the results are significant for both %HR max and accelerometer counts. The higher significance is due to the higher numbers  $n_m = 17$  and  $n_m = 18$  of subjects with much experience.

The practical consequence from Hypotheses 1 and 2 for Zumba is the finding that inexperienced and first time subjects carried out the session in around 70% of HR max, which is 10 to 15% lower than more experienced Zumba subjects. Given that the ideal training-sensitive zone is between 70 and 90% of HRmax (21), it is imperative (i.e., if the objective is to ensure that both inexperienced and experienced Zumba participants gain the same aerobic training outcome from one Zumba lesson) that the Zumba lesson should contain two levels of movements so that inexperienced participants are able to follow the instructor.

No rejection of Hypothesis 1 for 4x4 spinning means "no" significant difference between the experienced and the inexperienced subjects. The percent difference is negative, but negligible for %HR max and small for accelerometer counts. These results are likely explained by spinning being technically easier to learn than Zumba, thus enabling inexperienced subjects to exert a high effort. The no rejection of Hypothesis 2 for 4x4 spinning has the same explanation as no rejection of Hypothesis 1 for 4x4 spinning. Having experienced 4x4 spinning one time and more than one time gives no significant difference.

No rejection of Hypothesis 1 for 4x4 running means that there was no significant difference between the experienced and the inexperienced subjects. The percent difference was positive for %HR max, which suggests that experience is irrelevant. Hypothesis 1 for pyramid running is rejected for %HR max ( $P = 0.025$ ), but not rejected for accelerometer counts ( $P = 0.60$ ). The percent differences are small, -3.1% and -2.9%, respectively, expressing negligible difference between experienced and inexperienced subjects.

No rejection of Hypothesis 2 for pyramid running has the same explanation as no rejection of Hypothesis 1 for pyramid running and, therefore, having experienced pyramid running one time and more than one time gives no significant difference. The no rejection of Hypothesis 3 for Zumba (that is driven by the large correlation of 0.53-0.59) means that RPE does correlate with %HR max, accelerometer counts, and EE. The results were statistically significant at  $P < 0.002$ .

Regarding Hypothesis 3 for 4x4 spinning, the same logic applies only for %HR max, with no rejection due to reasonably large correlation 0.42 where  $P = 0.023$ . In contrast, for accelerometer counts and



energy expenditures the hypothesis was rejected due to non-significant P-values (though the correlation was much lower). This was caused by accelerometer counts for spinning being lower due to limited hip movement that resulted in a lower correlation.

As to Hypothesis 3 for 4x4 running, the results are again opposite. For %HR max no rejection occurred due to the non-significant  $P = 0.81$ . This result is somewhat surprising. It may be caused by low standard deviation in %HR max during 4x4 running compared with, for example, Zumba where the standard deviation was 2 to 3 times larger. In contrast, for accelerometer counts the hypothesis was not rejected due to a reasonably large correlation of 0.43 where  $P = 0.017$ . Energy expenditure did not have a significant correlation to RPE.

In regards to pyramid running (and Hypothesis 3), the results for %HR max are the same as for 4x4 running. That is, no rejection due to the non-significant P-value and negligible correlation that likely has the same explanation as for 4x4 running. For accelerometer counts the hypothesis was not rejected for the same reason and, similarly, for EE the hypothesis was not rejected.

Garcin et al. (10) found no effect of fitness level on RPE for a given relative exercise duration in running. In the present study, we did not find differences in RPE between the experienced and the inexperienced subjects in 4x4 running and pyramid running. Thus, we conclude that RPE in running is independent of both fitness level and experience.

Hypothesis 4 was rejected regarding the difference in RPE between all the four sessions except between 4x4 spinning and pyramid running where  $P = 0.088$ . More specifically, Zumba was perceived 18.8 to 23.3% less exhaustive than the other three sessions, even though Zumba lasted 15 min longer than the other sessions. The 4x4 running was perceived 6.3% and 3.2% less exhaustive than 4x4 spinning and pyramid running, respectively, and 4x4 spinning is perceived 2.9% more exhaustive than pyramid running.

## CONCLUSIONS

In Zumba, the more experienced subjects reported higher RPE than the less experienced subjects. They exercised at higher a %HR max and produced a higher number of accelerometer counts. Zumba is the only exercise session where the subjects had a significant correlation 0.5 to 0.6 between RPE and %HR max, accelerometer counts, and EE. In the other exercise sessions, no such consistent findings existed. The subjects' experiences with running and spinning sessions had little or no correlation with %HR max, accelerometer counts, and EE, except for accelerometer counts for 4x4 running.

We suggest that the reason for the difference between Zumba and the other three exercise sessions is that the non-experienced subjects in Zumba had a greater problem following the instructor's movements and intensity. This was not expected, but understandable since it takes time to learn the movements. Also, before they are learned, the non-experienced subjects do not perform full ranges of movement for most or all limbs and, therefore, do not move at a higher intensity. This is no doubt the reason why the non-experienced Zumba subjects perceived less exertion. Instructing beginners in Zumba requires more time than in spinning and running. Similar results may follow for other technical exercises compared with simple exercises such as running or spinning.

Finally, Zumba is perceived substantially less exhaustive than the other three sessions, 4x4 running is perceived slightly less exhaustive than 4x4 spinning and pyramid running, and 4x4 spinning is perceived slightly more exhaustive than pyramid running.

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