原著論文

Heart rate in Ballroom dance in Japanese professional dancers.

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Abstract : The present investigation was aimed to study Japanese professional competitive ballroom dancer's heart rate during competition choreography simulation in relation to the gender and dance style. A total of 10 couples (5 Standard couples and 5 Latin American couples) performed five different styles of 1 and 30 minutes for Standard and Latin American respectively. Heart rate was measured with wearable sensor attached on left chest with electrodes. The results showed that heart rate in all dances reached more than 150 bpm, which can be assumed as physically highly demanding. In Standard heart rate of leader was higher than in both leader and partner in Waltz, Viennese Waltz, and Slow Foxtrot. Highest heart rate was seen in Quickstep in partner. Latin American dance discipline of leader was more intensive in heart rate compared to partner in Samba, Rumba, Paso Doble and Jive. Between styles in each role heart rate was highest in Jive in leader and Samba in partner. In this experiment, each style of ballroom dance elicited physiological responses representative of moderate to vigorous physical activity.

Key words : ballroom dance, heart rate, professional dancer
キーワード :ボールルームダンス，心拍数，運動強度

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Ⅰ Introduction

Ballroom dancing is enjoying an interest and a popularity from all kinds of levels and generations in the world. In addition to hobby enthusiasts, there are groups of amateur and professional competitive dancers.

Ballroom dance is generally defined as partner dancing between a man and woman combining as a couple. Traditionally, the male dancer is the leader and the female is the partner. Additionally, ballroom dance can be divided into Standard and Latin American dance. Both of them consists of five dances: Waltz, Tango, Viennese Waltz, Slow Foxtrot, Quickstep for Standard and Cha cha cha, Samba, Rumba, Paso Doble, and Jive for Latin American, respectively, which are called styles or balls. In competition, dancers perform 5 balls in succession as one round. They dance each style for 90 to 120 seconds and take 15 to 20 seconds for rest in between. A typical competition requires dancers to dance a number of rounds to go to the final, which demands heavily physically.

There have been several studies on heart rate in ballroom dance players, some of which have been done on a hobby level and others on athletes. A few physiological researches have been done to clarify cardiovascular ability in ballroom dancers of elementary school kids (Huang et al., 2012; Uspuriene and Čepulėnas., 2012), amateur college students(Mangeri et al., 2014) and obese people with diabetes(Mangeri et al., 2014) to determine that ballroom dance stimulates cardiovascular function. Despite the increasing popularity, the physiological characteristic of ballroom dance in competitive dancers has not been investigated enough.

Measurements in regards to athletes have used a single to several rounds of a competition format in which five different styles are performed in succession. Previous studies have demonstrated that the competitive ballroom dancing is a vigorous physical activity requiring the cardiovascular system to work at high level energy expenditure in the competitive dance round routine(Blanksby and Reidy, 1988; Bria et al., 2011; Oreb et al., 2006). In such a competitive stimulation as a round routine, the fatigue accumulates while each styles of dance proceeds and it is difficult to evaluate the physiological demands in each of those style. However, no studies have examined the level of biological burden in each style of dance.

Therefore, the purpose of this study was to measure the heart rate of Japan's top ballroom dancers during a trial performance of each one of dance style for characterizing the physiological activity parameters of ballroom dance.

Ⅱ Material and methods

2.1 Subjects

20 top Japanese ballroom dancers were recruited. Subjects were 5 couples for Standard (Leader; age, 34.0 ± 5.2 years; height, 174.6 ± 5.0cm; weight, 66.4 ± 2.9 kg. Partner; age, 34.2±6.3 years; height, 162.2±5.0 cm; weight, 51.6 ± 5.2 kg) and 5 couples for Latin American (Leader; age, 35.4 ± 3.8years; height, 175.1 ± 4.3 cm; weight, 74.8 ± 5.2 kg. Partner; age, 33.2±6.4 years; height, 161.4±3.4 cm; weight, 55.2±3.3 kg). All subjects were fully informed of the purpose of the study, the content of the measurements and the risks associated with the measurements, and their consent to cooperate in the study was obtained after allowing them to withdraw from the study and respecting their free will to participate.

2.2 Procedure

After sufficient warming up, each of the Standard and Latin American groups performed 5 styles in their own choreography. Standard consisted of Waltz, Tango, Viennese Waltz, Slow Foxtrot, and Quickstep. Latin American Cha-cha-cha, Samba, Rumba, Paso Doble, and Jive. They are also called styles in text. Each dance lasted for 1 minute and 30 seconds. Rest period between styles was 28 minutes and 30 seconds to decrease heart rate. Rest period was determined according to Banksby and Reidy (1988) and Liiv et al., (2014). All subjects were dressed in their training costume and danced in their competition shoes for the same music of the style.

2.3 Material

To measure heart rate we used my Beat (Union tool, Tokyo). The wearable heart rate sensor was attached to the left chest of the subjects with Blue sensor P (Ambu, Malaysia) electrodes throughout entire measurement. The sensor sampled and calculated to read heart rate every 4 seconds and the data was logged in the portable sensor during the measurement. To clarify the cardiovascular demand of the dance we divided the duration of the each dance into 3 parts of 30 seconds (0-30sec, 30-60sec, and 60-90sec).

2.4 Statistics

Data are presented as the means and standard deviation (SD). The significance of difference among parameters between partners and events were tested using two-way analysis of variance. Data analysis was performed using BellCurve for Excel (Social Survey Research Information Co., Ltd. Tokyo, Japan) For all main effects and interactions, $p<0.05$ was applied for significance.

3. Results

Heart rate in standard 1 minutes and 30 seconds (Table 1A)

Resting heart rate was around 64.0 ± 8.2. And heart rate after warm up and right before dance increased up to 103.0 ± 4.6. In Standard, the heart rate of leader was higher than that of partner in Waltz ($p<0.01$), and Viennese Waltz ($p<0.01$), and Slow Foxtrot($p<0.01$). In partner, Tango was higher than Waltz and Viennese Waltz ($p<0.05$). And Quickstep washigher than Waltz, Viennese Waltz, and

Slow Foxtrot ($p<0.05$). There was a significant interaction between groups and dances ($p<0.05$).

Heart rate in each 30 seconds in Standard (Table 1 B,C,D)

To clarify the characteristics of each style, we divided the 1 minute and 30 seconds dance into 3 parts of 30 seconds. From 0 to 30 second, Waltz ($p<0.01$), Tango($p<0.01$), Viennese Waltz ($p<0.01$)and Slow Foxtrot($p<0.05$) were higher in leader than in partner. In leader group, Viennese Waltz was lower than Quickstep ($p<0.01$). In partner group, Quickstep was higher than rest of the four. There was no significant interaction between groups and dances.

From 30 to 60 second, between leader and partner, Waltz ($p<0.01$) and Viennese Waltz ($p<0.05$) were higher in leader. In partner group, Waltz was lower than Tango and Quickstep ($p<0.01$). Also Viennese Waltz was lower than Quickstep in partner ($p<0.05$). There was no difference in leader group. There was no significant interaction between groups and dances.

During 60 to 90 second, Tango was lower in leader than in partner ($p<0.01$). Viennese Waltz ($p<0.05$), Slow Foxtrot ($p<0.01$), and Quickstep ($p<0.01$) of leader were higher than those of partner. In leader group, Quickstep was higher than Tango. There was no significant interaction between groups and dances.

Table 1A

	0-90sec (bpm)	
	Leader	Partner
Waltz	145.3±5.2 **	134.9±9.2
Tango	144.3±11.9	145.1±13.8a
Viennese Waltz	144.3±4.4 **	135.4±18.4
Slow Foxtrot	143.3±1.3 **	139.1±8.4
Quickstep	147.3±1.6	150.5±5.3 b

Table 1B

	0-30sec(bpm)	
	Leader	Partner
Waltz	129.0±2.8 **	106.5±22.7 b
Tango	132.7±9.7 **	111.3±23.4 b
Viennese Waltz	118.3±7.9 **a	107.0±3.5 b
Slow Foxtrot	131.0±7.9 *	122.0±10.8 c
Quickstep	142.9±11.9	140.6±10.9

Table 1C

	30-60sec(bpm)	
	Leader	Partner
Waltz	150.3±4.8 **	139.0±6.6
Tango	157.0±3.9	153.1±11.5 a
Viennese Waltz	149.9±4.0 *	144.4±16.2 b
Slow Foxtrot	150.3±5.9	147.0±14.1
Quickstep	157.1±5.2	155.9±6.9 a

Table 1D

	60-90sec(bpm)	
	Leader	Partner
Waltz	157.1±3.8	153.1±14.0
Tango	148.0±18.0 **a	161.3±10.9
Viennese Waltz	162.1±4.4 *	154.9±19.7
Slow Foxtrot	159.7±4.6 **	145.0±9.1
Quickstep	165.4±5.3 **	155.1±8.0

Heart rate (bpm) in Standard 1minute and 30 seconds dance (A), from 0 to 30 seconds dance (B), 30 to 60 seconds (C), and 60 to90 seconds(D).

Values are presented as means and SDs. *and ** denote a significant difference between leader and partner at $p<0.05$ and $p<0.01$, respectively.

(A) a denotes a significant difference Tango vs Waltz and Viennese Waltz in patrner at $p<0.05$. b denotes a significant difference Quickstep vs Waltz, Viennese Waltz, Waltz, and Slow foxtrot in partner at $p<0.01$.

(B)a denotes a significant difference Viennese Walz vs Quickstep in leader at $p<0.01$. b and c denotes significant difference against Quickstep at at $p<0.05$ and $P<0.01$, respectively in partner.

(C) a denotes a significant difference against Waltz at $p<0.01$.

b denotes a significant difference against Quickstep at $p<0.05$ in partner.

(D) a denotes a significant difference against Quickstep at $p<0.05$

Heart rate in Latin American 1 minutes and 30 seconds (Table 2 A)

In Latin American there was a significant difference in the heart rates in 1 minute and 30 seconds dance in Samba($p<0.01$), Rumba($p<0.05$), Paso Doble($p<0.05$) and Jive($p<0.05$) between couple. In leader, Rumba ($p<0.01$), Paso Doble($p<0.05$), and Jive($p<0.05$) were higher than Samba. There was no significant interaction between groups and dances.

Heart rate in each 30 seconds in Latin American(Table 2 B, C, D)

In 0 to 30 second, Cha cha cha($p<0.05$), Samba($p<0.01$) and Jive($p<0.01$) were higher in leader than in partner. Between leader`s styles, Jive was higher than Cha cha cha($p<0.05$) and Rumba($p<0.05$). In partner group, Rumba was lower than Cha cha cha($p<0.05$), Samba($p<0.05$), and Paso Doble($p<0.01$). There was no significant interaction between groups and dances.

From 30 to 60 second, Jive showed higher heart rate in leader than partner($p<0.05$). In leader group, Jive was higher than Paso Doble($p<0.05$). There was no significant interaction between groups and dances.

During last 30 second, between leader and partner, in Samba leader was lower than partner($p<0.01$). But Paso Doble and Jive were higher in leader($p<0.01$). In partner group, Samba was higher than Paso Doble($p<0.01$) and Jive($p<0.05$). There was a significant interaction between groups and dances ($p<0.05$).

Table 2A

	0-90sec(bpm)	
	Leader	Partner
Cha cha cha	146.5±10.2	146.8±14.2
Samba	148.7±16.4	152.4±6.2
Rumba	144.6±10.8*a	140.6±11.8
Paso Doble	152.2±7.7 *b	144.5±12.8
Jive	158.7±7.3 *b	145.6±9.1

Table 2B

	0-30sec(bpm)	
	Leader	Partner
Cha cha cha	132.7±7.8*a	140.6±15.1 b
Samba	144.2±13.3	140.1±16.1 b
Rumba	134.6±8.3**a	123.6±12.8
Paso Doble	145.6±11.0	144.1±15.4 c
Jive	151.0±8.4 **	139.2±9.4

Table 2C

	30-60sec(bpm)	
	Leader	Partner
Cha cha cha	149.8±14.8	142.1±18.6
Samba	158.4±27.1	153.5±3.7
Rumba	151.2±12.8	145.6±7.8
Paso Doble	148.1±18.7 a	147.0±15.7
Jive	162.4±11.1 *	152.8±10.5

Table 2D

	60-90sec(bpm)	
	Leader	Partner
Cha cha cha	164.2±11.9	154.6±18.9
Samba	148.0±32.7 **	166.4±7.5
Rumba	150.1±17.6	157.6±12.8
Paso Doble	161.0±9.7 **a	140.3±27.1
Jive	163.2±12.0**b	144.3±19.4

Heart rate (bpm) in Latin American 1minute and 30 seconds dance (A), from 0 to 30 seconds dance (B), 30 to 60 seconds (C), and 60 to90 seconds(D).
Values are presented as means and SDs. *and ** denote a significant difference between leader and partner at $p<0.05$ and $p<0.01$, respectively.
(A) a and b denote a significant difference against Samba at $p<0.01$ and $p<0.05$, respectively in leader.
(B) a denotes a significant difference against Jive at $p<0.05$ in leader. b and c denote a significant difference against Rumba at $p<0.05$ and $p<0.01$, respectively in partner.
(C) a denotes a significant difference against Jive at $p<0.05$.
(D) a and b denotes a significant difference against Samba at $p<0.01$ and $p<0.05$, respectively in leader.

Ⅳ Discussion

The present investigation was aimed to study Japanese elite level ballroom dancers' aerobic characteristics during each style of dance. To date, there are no studies conducted in this condition. This simulation should give us better understanding of cardiovascular characteristics of each style of ballroom dance. An important finding of this study is that competitive level of each style of ballroom dance can meet the high heart rate and exercise intensity.

In the present measurement, the average heart rate for 90 seconds of dancing was as high as previous studies (Blanksby and Reidy, 1988; Bria et al., 2011; Oreb et al.,2006). These results demonstrate that male and female ballroom dancers show relatively high values for aerobic capacity compared to other dances like ballet(Cohen et al.,1982; Oreb et al., 2006; Schantz and Astrand, 1984; Wyon et al., 2007), modern dance(Chmelar et al., 1988), flamenco (Pedersen et al., 2001) and folk dance (Schantz and Astrand, 1984). Exercise which results in a heart rate range over 150 bpm has been classified as heavy (Suggs, 1968) or extremely heavy (Astrand and Rodahl, 1977). According to this definition, competitive ballroom dance in last phase of style is a vigorous activity requiring the high energy expenditure with cardiovascular system. Dancing at a heart rate in excess of 80% maximal heart rate is also likely to have a physiological training effect (Astrand and Rodahl, 1977).

Standard dances consisted of different energy demanding styles. Heart rate was particularly high in Quickstep. Tango showed lower heart rate. This result was similar to the report by Bria et al.(2011). Also in Latin American Samba had lower heart rate and Paso Doble and Jive were higher which was in accordance with previous research(Bria et al., 2011). We assume this is due to the tempo of the each dance style. The results of heart rate appears that the second styles (Tango and Samba) have lower heart rate and heart rate increases in latter half in both dances. Since the movement of the dance is largely dependent on the tempo of the music, we can hypothesize that Tango is lower intensity for male and Slow Foxtrot is lower energy demanding for female in this experiment.

In Standard and Latin American, leader tended to show higher heart rate in this experiment. This result was accordance with Jensen at al.(2002). Partner seems to move more dynamically than leader especially in Latin American. Therefore, heart rate of partner is thought to be higher than that of leader. However, this was not the case in this experiment. Actually, the leader is responsible for guiding the couple and initiating transitions to different dance steps and, in improvised dances, for choosing the dance steps to perform. The leader communicates choices to the follower, and directs the follower by means of subtle physical and visual signals, thereby allowing the pair to be smoothly coordinated.(DeMers, 2013) Even though leader has more static movement, he holds and controls the partner to govern the dance, which elicited higher heart

rate.

The heart rate is usually measured when it reaches the steady state during aerobic exercise. In this experiment, the researchers were able to observe changes in the way the heart rate rose by dividing the dance into three parts so that the intensity of the dance can be evaluated. There was significant differences in the rise in heart rate during the dance from 0 to 30 seconds in Quickstep. The rise of heart rate in Quickstep was swift which suggests Quickstep is a higher intensity dance.

In this experiment, we didn't compare heart rate between Standard and Latin American because the dancers didn't perform the both dances. Further studies are needed to clarify the physiological demands on ballroom dancers.

Dancers perform at such a high level of exercise intensity that an understanding of these energy demands may help build specific training programs to keep a quality of dance performance over rounds of a competition.

Ⅴ Conclusion

Accurate quantification of heart rate for competitive ballroom dance provides a deeper understanding of its physiological demands. This is the first study to measure the cardiovascular intensity of each style of ballroom dance. An important finding of this study is that competitive ballroom dance can meet the very high heart rate and elicit physiological responses representative of moderate to vigorous physical activity. In order to compete, elite competitive dancers have to do hard training to improve their competition performance.

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