原著論文

Heart rate during competition simulation rounds 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 rounds and dance style. A total of 10 couples (5 Standard couples and 5 Latin American couples) performed 2 rounds of 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 170 bpm, which can be assumed as physically highly demanding. In Standard the maximum heart rate of leader in the second round was higher than in the first round in Tango, Viennese Waltz, and Slow Foxtrot. In the second round, Waltz was lower than Tango, Viennese Waltz and Slow Foxtrot. In Latin American dance the maximum heart rate of Samba and Jive in leader was lower in the second round than in the first round. In this experiment, each style of ballroom dance during the round 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，プロフェッショナルダンサー

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Ⅰ Introduction

Ballroom dancing is enjoying an interest and increasing its popularity from all kinds of levels and generations in the world. In addition to recreational enthusiasts, there are groups of amateur and professional competitive dancers. Ballroom dance is generally defined as partner dancing between a man and a 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 for specialities. 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 high cardiovascular and aerobic capacity.

There have been several studies on heart rate in ballroom dance players. Some of which have been done on a hobby level dancers 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; Lankford et al., 2019) and obese people with diabetes(Mangeri et al, 2014) to determine that ballroom dance stimulates cardiovascular function. Despite the increasing its popularity and level of dance, 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 in top amateur and professional during one round (Blanksby and Reidy et al., 1988), top amateur in one round (Bria et al., 2011), elite during three rounds (Liiv et al, 2014), and experienced Latin amateur during one round (Liebana et al, 2021). In such a competitive format as a round routine, the fatigue accumulates while each styles of dance proceeds so that the heart rate increases. However, few studies have examined the level of biological burden in multiple rounds in professional dancers which simulate the competition.

Therefore, the purpose of this study was to measure the heart rate of Japan's professional ballroom dancers during consecutive rounds for characterizing the physiological and physical activity parameters of ballroom dance.

Ⅱ Material and methods

2-1. Subjects

20 top Japanese ballroom dancers were recruited from: Japanese Ballroom Dance Federation. Subjects were 5 couples for Standard (Leader (male); age, 34.0 ± 5.2 years; height, 174.6 ± 5.0cm; weight, 66.4 ± 2.9 kg. Partner (female); 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 2 rounds of 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 30 seconds. They also took rest for 20 minutes between the rounds 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 read and calculated 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 measured the maximum heart rate during the each style.

2-4. Statistics

Data are presented as the means and standard deviation (SD). The significance of difference in maximum heart rate between rounds and events were tested using two-way analysis of variance. Bonferrini was used for multiple comparison. The effect size was calculated using Cohen's d formula. 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.

Ⅲ Results

Average heart rate in rounds

Changes of average heart rates during rounds in Standard and Latin American in leader and partner are shown in Fig 1,2,3,4. In leader and partner of Standard and in partner of Latin America, the average heart rate seemed to increase in the second round from first round.

Maximum heart rate in Standard leader (Table 1A)

In leader in Standard , the maximum heart rate of second round was higher than that of first round in Tango ($p<0.05$), Viennese Waltz ($p<0.01$) and Slow Foxtrot ($p<0.01$). In the second round Waltz was lower than Tango ($p<0.05$), Viennese Waltz ($p<0.01$) and Slow Foxtrot ($p<0.01$). There was no interaction between round and style.

Maximum heart rate in Standard partner (Table 1B)

In partner in Standard, the maximum heart rate in the second round was higher than that in the first round in Tango ($p<0.01$) and lower in Viennese Waltz ($p<0.01$). In the first round, Viennese Waltz was higher than Slow Foxtrot ($p<0.01$). No interaction was found between round and style.

Maximum heart rate in Latin American leader (Table 2A)

Maximum heart rate in Samba ($p<0.01$) and Jive ($p<0.01$) in the second round were significantly lower than those in the first round.

Maximum heart rate in Latin American partner (Table 2B)

There was no significant difference between the rounds and styles.

Ⅳ Discussion

The present investigation was aimed to study Japanese elite level ballroom dancers' aerobic characteristics during 2 rounds of 5 styles of dance. To date, there are no studies conducted in the condition which was similar to real competition and done by professional dancers. This measurement should give us better understanding of cardiovascular characteristics in the rounds of ballroom dance in competition. An important finding of this study is that competitive level of multiple rounds of ballroom dance can meet the high heart rate and exercise intensity.

In the present simulation, the maximum heart rate for 1 minute and 30 seconds of dancing was as high as previous studies (Blanksby and Reidy, 1988; Bria et al., 2011; Liebana et al., 2021). 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

Table 1

Maximum heart rate in leader in Standard

	round1	round2
	bpm	bpm
Waltz	178.4 ± 3.9	179.5 ± 3.6
Tango	181.8 ± 3.7	183.5 ± 1.4 * a
Viennese Waltz	180.3 ± 4.4	184.8 ± 0.6 ** a
Slow Foxtrot	180.6 ± 2.2	183.7 ± 1.0 ** a
Quick Step	181.6 ± 1.4	182.5 ± 1.3

Values are presented as means and SDs. * denotes a significant difference between rounds at $p<0.05$. a denotes a significant difference with waltz in second round at $p<0.05$.

Table 2

Maximum heart rate in partner in Standard

	round1	round2
	bpm	bpm
Waltz	180.3 ± 1.9	181.2 ± 3.2
Tango	179.0 ± 4.2	183.4 ± 1.6 *
Viennese Waltz	185.2 ± 2.9	180.8 ± 2.9 *
Slow Foxtrot	177.7 ± 9.5	179.5 ± 5.2
Quick Step	179.7 ± 4.9	178.4 ± 5.3

Values are presented as means and SDs. * denotes a significant difference between rounds at $p<0.05$. a denotes a significant difference with slow foxtrot in first round at $p<0.05$.

Table 3

Maximum heart rate in leader in Latin American

	round1	round2
	bpm	bpm
Cha cha cha	181.2 ± 2.9	182.4 ± 1.8
Samba	181.6 ± 3.2	175.3 ± 12.5 *
Rumba	182.1 ± 2.2	179.2 ± 5.9
Paso Doble	180.0 ± 9.9	180.6 ± 7.3
Jive	182.8 ± 2.4	174.3 ± 14.6 *

Values are presented as means and SDs. * denotes a significant difference between rounds at $p<0.05$.

Table 4

Maximum heart rate in partner in Latin American

	round1	round2
	bpm	bpm
Cha cha cha	167.8 ± 19.0	168.2 ± 28.2
Samba	169.4 ± 27.5	182.4 ± 2.0
Rumba	164.4 ± 24.5	164.7 ± 25.7
Paso Doble	169.2 ± 27.8	165.9 ± 32.5
Jive	179.9 ± 4.5	181.1 ± 5.5

Values are presented as means and SDs. There was no difference between rounds and styles.

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 multiple rounds 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).

We compared heart rate between the rounds to investigate the effect of repeating rounds on the heart rate. In leader of Standard, maximum heart rate in second round was particularly higher in Tango, Viennese Waltz and Slow Foxtrot than those in first round. This implies that the fatigue was accumulated and the intensity of dance increased in the second round. Between the styles, there was no difference in the maximum heart rate in the first round. They reached around 180bpm. However in second round, Tango, Viennese Waltz and Slow Foxtrot further showed higher heart rate than Waltz. The results indicate that repeated rounds showed Standard dances consisted of different energy demanding styles. If we use the Karvonen formula, the maximum heart rate during the simulation indicates more than 90% of predicted exercise intensity (Bria et al., 2011, Riebe et al., 2018).

In partner, the maximum heart rate increased in the Tango of second round compared to that of the first round. On the contrary, Viennese Waltz showed lower heart rate in the second round. According to the rules of World Dance Council, the tempo of Viennese Waltz is the highest in the five styles which may explain the decline in the second round because the dancers might not be able to maintain the high tempo, speed and intensity of the style.

In Latin American the maximum heart rate of leader reached more than 180bpm in the whole first round. This demonstrated that the dancers performed the explosive and high intensity choreography. In the second round Samba and Jive decreased heart rate. It indicates that since the tempo of the two dances is so fast that dancers could not keep up the pace in the second round. On the other hand, the partner did not show the significant difference in the heart rate between the rounds and dances even though Samba and Jive peaked 180bpm. This is partially explained that the choreographies of partner in Latin American were varied in each dancer so that SDs of the heat rate were large compared to that of leader or those of Standard couples. The effect size between Samba and Jive in the first round in partner was 1.16. And the effect size of Samba between first and second round was 0.81.

In both Standard and Latin American the maximum heart rate increased to about 180bpm and kept the pace through five dances in each round. 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

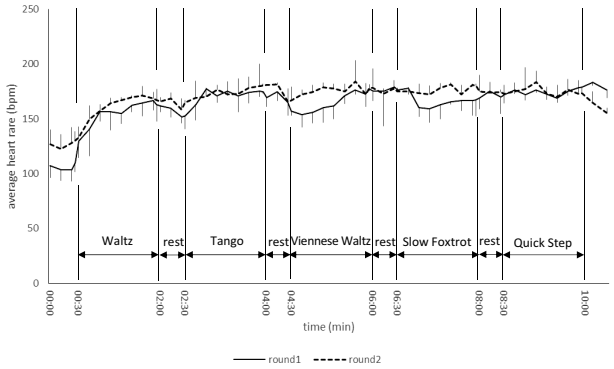

Figure 1. Changes in average heart rate during competition simulation in leader of Standard.

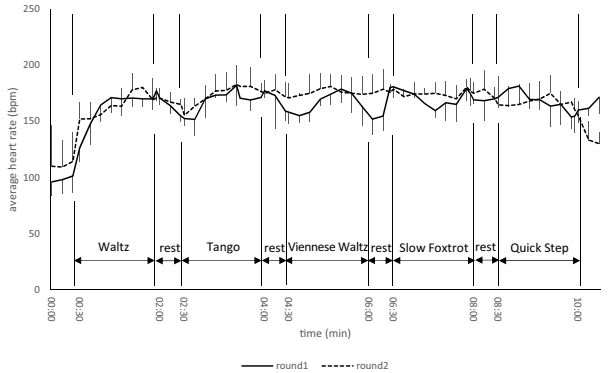

Figure 2. Changes in average heart rate during competition simulation in partner of Standard.

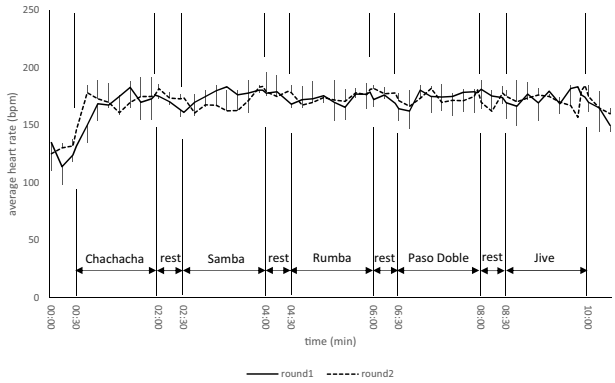

Figure 3. Changes in average heart rate during competition simulation in leader of Latin American.

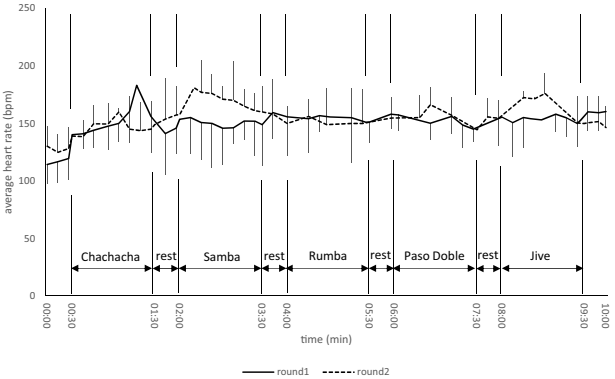

Figure 4. Changes in average heart rate during competition simulation in partner of Latin American.

performance over rounds of a competition. The results in this experiment resemble high intensity interval training with intensity of glycolytic metabolism. Therefore it may be beneficial to do general high intensity interval training for cardiovascular improvement for placing better in the competition besides choreographic practice.

One of the limitation of this research is that we did not measure the kinematics and the dance quality of the pairs which may affect the load during the dance. It would explain the situation of the maximum heart rate in leader of Latin American for the decline in the second round.

Additionally, we did not compare the heart rates in leader and partner since their choreographies are not the same. Vaczi et al.(2016) reported that the load of female dancer is more intensive because of the typical way of holding during dance. We assume it is difficult to simply compare the heart rate to determine the physiological demand of dance between leader and partner

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 in the repeated rounds in professional dancers. An important finding of this study is that competitive ballroom dance can meet the very high heart rate and elicit physiological responses representative of vigorous physical activity during multiple rounds. In order to compete, elite competitive dancers need to do high intensity interval training to improve their competition performance.

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