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Senior Competitive Ballroom Dancers Underestimate their Exertion in Final Rounds Training

Ältere Turniertanzpaare unterschätzen ihre Belastung im Endrundentraining

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Summary

- **Knowledge about** individual strain in competitive ballroom dancing is limited, particular for senior couples. We evaluated the exertion during a simulated final round, covering all five tournament ballroom dances. Heartrate, blood-lactate, and rate of perceived exertion (RPE, Borg-scale) were measured.
- **In this prospective observational study** 27 couples (12 couples 20-39ys, 15 couples 40-78ys), performed a final round, sequence Slow Waltz (SW), Tango (TG), Viennese Waltz (VW), Slow Foxtrot (SF), and Quickstep (QS), each duration 1:45min, 30s break, 2min cool-down. Lactate was measured before warm-up, before SW, and after QS. During each break both partners estimated their individual RPE. ECG was registered continuously. Individual HRmax was calculated according to: HRmax=207–(age x 0.7). RPE values were transferred to corresponding percent of HRmax, according to Borg.
- **Lactate at rest** was about 1.4mmol/l (warm-up 2mmol/l), after five dances 3.5±2.4mmol/l (young ladies), 5.9±2.2mmol/l (senior ladies (p=0.016)), 6.5±3.4 mmol/l (young men), 7.2±3.0 mmol/l (senior men). HR-development was similar in all dancers with highest values in VW and QS. The younger remained below 100%HRmax, senior ladies reached 105.4±7.4%, men 107.5±6.6%HRmax in QS. All couples underestimated their exertion in comparison of transferred RPE-values to measured %HRmax. The younger became more realistic from VW on, the seniors continued to significantly underestimate throughout all dances.
- **Conclusion:** Competitive final-round training is strenuous and partly anaerobic exertion, particular for older dancers, who reach more than 100% of predicted HRmax. The older couples more severely underestimate their strain.

Zusammenfassung

- **Es ist wenig bekannt** über die körperliche Belastung im Turniertanzsport, besonders bei Seniorenpaaren. Wir untersuchten die Belastung in einer simulierten Turnier-Endrunde mit allen fünf Tänzen. Herzfrequenz, Blutlaktat und Maß der empfundenen Belastung (RPE, Borg-Skala) wurden gemessen.
- **Die prospektive Beobachtungsstudie** wurde an 27 Paaren (12 Paare 20-39J., 15 Paare 40-78J.) während Turnier-Endrunde mit Sequenz Langsamer Walzer (SW), Tango (TG), Wiener Walzer (VW), Slow Foxtrott (SF), Quickstep (QS), jeweils Dauer 1:45min, 30s Pause, 2min cool-down durchgeführt. Laktatmessung erfolgte vor warm-up, vor SW, nach QS. In jeder Pause schätzten beide Partner ihre individuelle RPE ein, kontinuierliche EKG-Registrierung mit Kalkulation der individuellen HR_{max} nach: HR_{max}=207-(age x 0.7). RPE-Werte wurden in % HR_{max} übertragen gemäß Borg.
- **Laktat lag in Ruhe** um 1.4mmol/l (warm-up 2mmol/l), nach fünf Tänzen 3.5±2.4mmol/l (junge Damen), 5.9±2.2mmol/l (Senior Damen (p=0.016)), 6.5±3.4 mmol/l (junge Herren), 7.2±3.0 mmol/l (Senior Herren). Herzfrequenzverhalten war ähnlich bei allen Tänzern mit Spitzenwerten in VW und QS. Die Jüngeren blieben unter 100% HR_{max}, in QS erreichten die Senior Damen 105.4±7.4%, Senior Herren 107.5±6.6% HR_{max}. Alle Paare unterschätzten ihre Belastung (% HR_{max} kalkuliert aus RPE) im Vergleich zu gemessenen % HR_{max}. Die Jüngeren schätzten realistischer ab VW, die Senioren unterschätzten ihre Belastung signifikant in allen Tänzen.
- **Schlussfolgerung:** Turniertanz-Endrundentraining ist eine sehr anstrengende und eine teilweise anaerobe Belastung, speziell für Senioren, die mehr als 100% individuelles HR_{max} erreichen. Auch neigen die Senioren besonders zur Unterschätzung ihrer Belastung.

KEY WORDS:
Strain Estimation, Lactate, Heartrate, Perceived Exertion

SCHLÜSSELWÖRTER:
Belastungsabschätzung, Laktat, Herzfrequenz, wahrgenommene Anstrengung

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Introduction

Competitive ballroom dancing is practiced in Germany in thousands younger as well as older couples, with active senior dancing couples ranging from about 40 years until 75 years of age, and sometimes older. Juniors as well as seniors participate in organized tournaments in different age groups, become judged by adjudicators, and therefore aim to perform at their best.

It has been shown before, that competitive dancing is a strenuous sport, but the available data primarily base upon some studies in young world-elite dancers (1)(3)(6)(9), whereas also thousands of senior couples practice their sport on a high level on well-attended tournaments. In current literature, however, Ballroom Dancing in seniors is normally investigated as health-providing

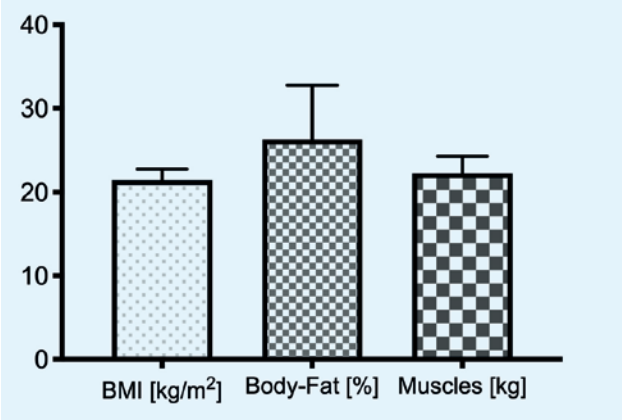

Figure 1a

Body composition data from young ladies derived from NutriPlus 3. All data means ± SD.

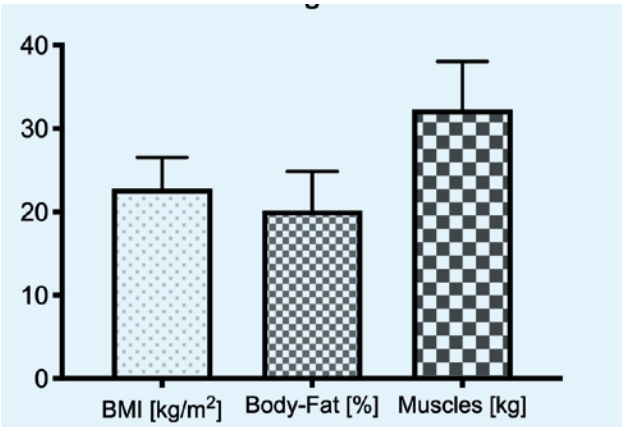

Figure 1b

Body composition data from young men derived from NutriPlus 3. All data means ± SD.

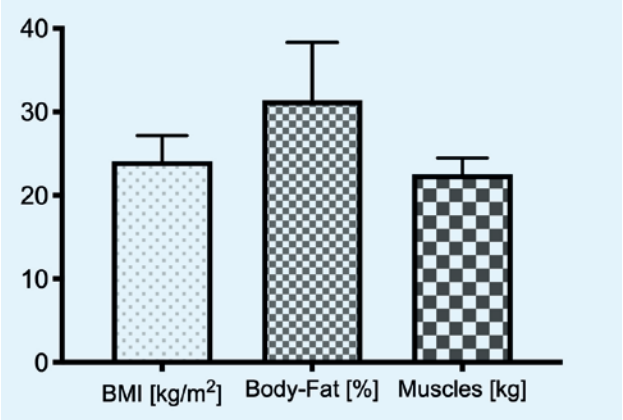

Figure 1c

Body composition data from senior ladies derived from NutriPlus 3. All data means ± SD.

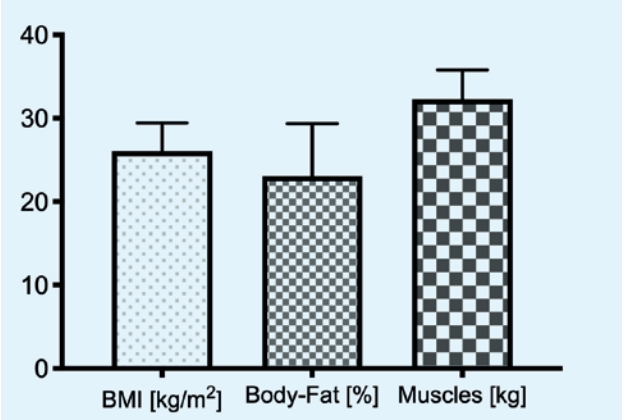

Figure 1d

Body composition data from senior men derived from NutriPlus 3. All data means ± SD.

leisure activity, neglecting competitive Ballroom Dancing in tournaments (8).

In contrast to some other sports disciplines like SCUBA-diving, where a medical fitness certificate is necessary, medical examinations for competitive dancers are unusual, for seniors either. Also, unlike in high-level running or cycling, sports-physiologic measurements of dancers´ performance seem to be uncommon, again particular in seniors.

Thus, since overall knowledge about the individual strain in competitive dance-training and tournaments is limited up to now, there is nearly no information available about the relevant group of senior competitive dancers. Moreover, dancing is an aesthetic sport, and the couples try to demonstrate easiness and elegancy, and therefore dancers of all age groups may dissimulate their strain during competition, and their body composition may significantly differ from people with more sedentary lifestyle.

It was the aim of this study to evaluate the individual physical strain in younger and older competitive dancing couples during a simulated final round, covering all five tournament ballroom dances.

The focus was set on actual body composition, heart rate, blood lactate development, and rate of perceived exertion (Borg scale).

Methods

The study was designed as a prospective observational study in two groups of competitive dancers, overall 27 couples. The group of younger dancers consisted of 12 couples between 20-39 years, the group of older dancers covered 15 couples between 40-78 years.

All couples were well in training and usually performed a final round with their own choreography at least once a week. Thus, the study setting was not different from regular competition training, and therefore was suitable to mirror the real strain in training.

All dancers were clinically fit with only minor actual and previous smoking habits. Every participant had given informed consent before the study, which was approved by the local Ethics Committee.

Final Round Test

Each couple performed a complete final round as shown in the scheme. Before, in the preparation phase, body composition was measured with the BIA-method, and each partner was equipped with a Holter-ECG. Additionally, blood was taken from the hyperemized earlobe for first lactate measurement. An individual warm-up followed the preparation, with capillary blood sampling for second lactate measurement. ›

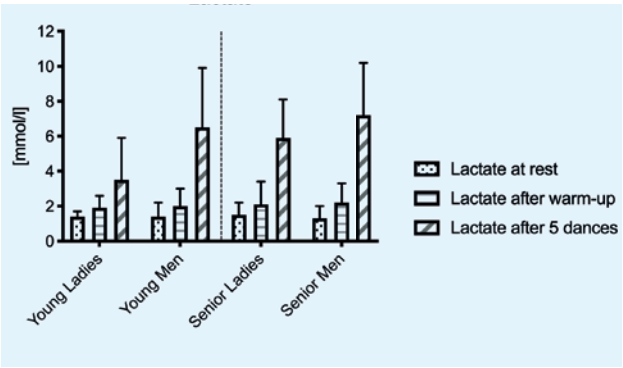

Figure 2

Results from the lactate-measurements at rest, after warm-up, and after completing the final round. All data means ±SD.

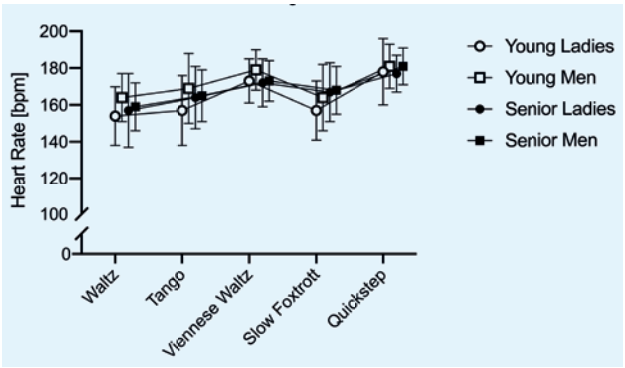

Figure 3

Measured heart rates by Holter-ECG during the five dances in the young and senior couples. All data means ±SD.

Then, the final round started with the Slow Waltz (1:45min, 0:30min break), followed by Tango (1:45min, 0:30min break), Vienna Waltz (1:45min, 0:30min break), Slow Foxtrott (1:45min, 0:30min break), and finally the Quickstep (1:45min). The final round was completed by a cool-down phase for two minutes. The third blood sample for lactate-measurement was taken from both partners near the end of the cool down-phase after Quickstep. During the break after each dance both partner of the couple were asked for their individual RPE-estimation.

Body Composition

Body composition was measured with the Body-Impedance-Analysis on the test day in supine position according to the manufacturer´s guidelines (NutriPlus® with Nutri3®-software (2005), Data Input GmbH, Germany).

Heart Rate Measurement

Heart rate was measured continuously with the Holter-system Lifecard CF® (Delmar Reynolds, USA, 12Bit accuracy)

Blood Lactate Measurement

Blood lactate was measured in capillary blood (10µl) taken from the earlobe with the miniphotometer LP20 (Dr. Lange GmbH, Germany, filter 520nm) according to the manufacturer's guidelines.

Rating of Perceived Exertion (Borg-RPE scale)

The RPE was individually estimated between 6 and 20 according to the Borg-scale (2). The Borg-scale with interpretation in German was printed on a DinA4-papersheet and presented to the dancers for optical control before RPE-estimation.

Predicted Maximum Heart Rate (HR_{max})

Individual HR_{max} was calculated according to the formula: HR_{max}=207–(age x 0.7)(4).

Objective versus Subjective Perceived Exertion

The rating of perceived exertion (RPE) according to the Borg-scale is good correlated to a number of physiological measures of exercise intensity in large cohorts (11). Borg published own data about RPE and exercise heart rate in 2004, from which the following classification was derived:

RPE scale (adapted to (2)):

<10:	very light:	<35% HR_{max}
10-11:	fairly light:	35-54% HR_{max}
12-13:	somewhat hard:	55-69% HR_{max}
14-16:	hard:	70-89% HR_{max}
17-18:	very hard:	>89% HR_{max}
19-20:	very, very hard:	up to 100% HR_{max}

All dancers in the study gave an estimation of their exertion after each dance as RPE-value, not knowing their actual heart rate, which was recorded with the Holter-system. After transformation of the individual RPE-values into % HR_{max}, the differences between the subjective perceived exertion in % HR_{max} and the measured % HR_{max}, calculated from Holter-ECG and individual predicted HR_{max}, could be computed.

Statistics

For figures and calculations GraphPad Prism8 (GraphPad Inc., La Jolla, CA, USA) was used. Significance calculations were done with one-way Analysis of Variance and post-hoc Bonferroni´s multiple comparisons test. All data are presented as means ± SD. *:p<0.05; **:p<0.01; ***:p<0.001.

Results

Body Composition:

A complete body impedance analysis could be obtained in 9 from the 12 young couples, and in 13 from the 15 senior couples. Three young and two senior couples could not be measured because of a technical problem with the BIA-system.

In the senior couples BMI and body-fat were slightly higher (not significant), muscle-mass showed no differences between the younger and the senior (Figure 1a, 1b, 1c, 1d).

Lactate

Lactate at rest was within normal resting range in all dancers, and after warm-up comfortably inside the aerobic zone, without significant differences. Lactate after the five dances was borderline to the anaerobic zone in the young ladies, but entered the anaerobic zone in the senior ladies as well as in both age groups of men. The difference between young and senior ladies was significant (p=0.016) (Figure 2).

Heart Rate and Rates of Perceived Exertion (RPE)

In all four groups the dancers heart rates lay between >150bpm

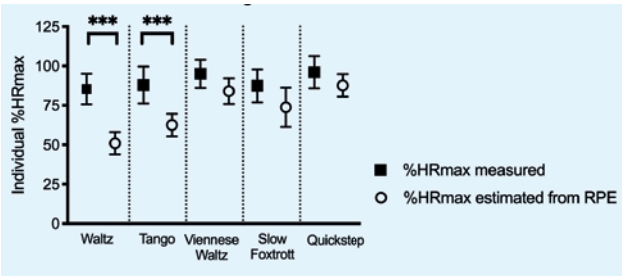

Figure 4a

Results for heart rate in percent predicted (%HR_{max}) for the young ladies. Black squares: %HR_{max} measured by Holter-ECG in percent predicted. White circles: %HR_{max} as predicted from RPE according to Borg. All data means ±SD. *:p<0.05; **:p<0.01; ***:p<0.001.

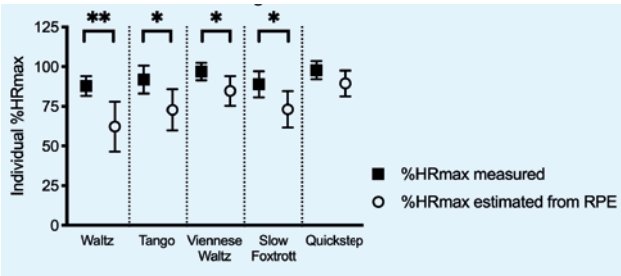

Figure 4b

Results for heart rate in percent predicted (%HR_{max}) for the young men. Black squares: %HR_{max} measured by Holter-ECG in percent predicted. White circles: %HR_{max} as predicted from RPE according to Borg. All data means ±SD. *:p<0.05; **:p<0.01; ***:p<0.001.

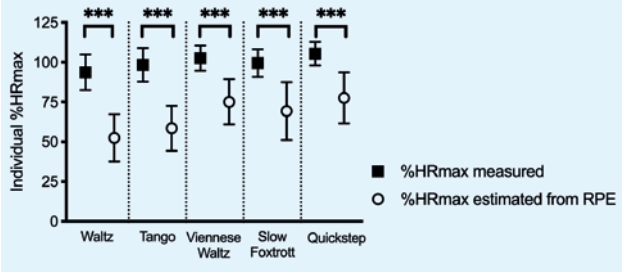

Figure 4c

Results for heart rate in percent predicted (%HR_{max}) for the senior ladies. Black squares: %HR_{max} measured by Holter-ECG in percent predicted. White circles: %HR_{max} as predicted from RPE according to Borg. All data means ±SD. *:p<0.05; **:p<0.01; ***:p<0.001.

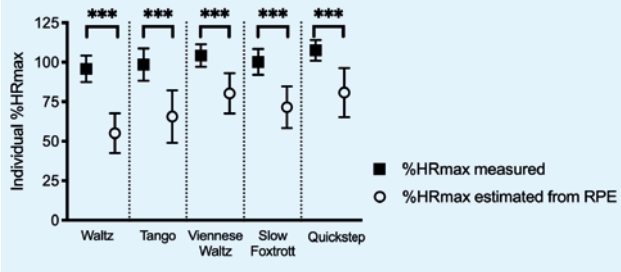

Figure 4d

Results for heart rate in percent predicted (%HR_{max}) for the senior men. Black squares: %HR_{max} measured by Holter-ECG in percent predicted. White circles: %HR_{max} as predicted from RPE according to Borg. All data means ±SD. *:p<0.05; **:p<0.01; ***:p<0.001.

and about 180bpm, and thus reached or nearly reached their individual maximum predicted HR (% HR_{max}), particular in Viennese Waltz and the final Quickstep. The were no major differences between the younger and the older, ladies and men in both, recorded heart rates and the derived % HR_{max} (Figure 3 and Table 1).

However, there were relevant differences between the measured heart rates and the estimated heart rates from the degree of perceived exertion (Table 2), according to Borg (%RPE).

All dancers underestimated their exertion, particular in the first dances Slow Waltz and Tango, but in the younger couples the differences became only small from the third dance on, the Viennese Waltz, which indicates a fairly good self-estimation of the actual exertion in the younger (Figure 4a-b).

The older however, senior ladies and men, further underestimated their exertion throughout all five dances. The differences % HR_{max} measured minus % HR_{max} estimated from RPE for all five dances were for young ladies: 18.56±10.98bpm, senior ladies: 33.32±6.7bpm (p<0.05), young men: 16.22±6.59bpm, and senior men: 30.58±6.54bpm (p<0.01)(Figure 4c-d).

Thus, taken together, seniors ladies and men significantly underestimated their exertion compared to their measured heartrates in all five dances, whereas the younger ladies and men significantly did so only during the first dances.

Discussion

Our data show, that final rounds training in competitive ballroom dancing is a partially anaerobic exertion, that can lead to maximal heartrate response in younger as well as older couples. However, particular the older couples seem to underestimate their exertion compared to the younger ones.

Ballroom Dancing is well known as a health-providing leisure activity (10), but information is limited about competitive ballroom dancing and primarily focused on world-elite couples (1,3,6). Recently, Vaczi and coworkers (12) have demonstrated, that Ballroom Dancing is a vigorous physical activity not only for world-elite, but also for amateur-tournament couples, challenging maximal heart rate and leading to relevant lactate increases, which indicate exhausting exertion. In this study (12) however, the authors have only focused on younger couples, and up to now, no data are available about the level of exertion in Ballroom Dancing in older couples, who are dancing completely comparable tournaments in their own age classes.

In our study we have included both age groups, and for our younger couples, the presented results are in good accordance to Vaczi et al., particular with respect to heartrate response and lactate levels.

The young couples in both studies reached more or less maximum heartrate during the simulated competitions, and even the peak lactate of the young men of about 6.5mmol/l was directly comparable. Only the young ladies in our setting presented with lower lactate levels of about 3.5mmol/l, which is partly in contrast to some results of Vaczi et al.. On the basis of heartrate and oxygen consumption they had found that ballroom dancing is more intensive for females and explained this with the ladies´ unique hold technique. In our study both, the younger and the senior ladies, showed comparable heartrates but lower lactate levels than their male partners during final round. This might be due in our ladies to more passive movement and less strong hold during the dances. However, the lower lactate values after the final round in our ladies compared to their male partners would also fit to their lower muscle mass as awaited (13) and ›

Table 1

Measured heart rates in percent individual HRmax during the dances and heart rate-decreases in percent during the breaks and 2min after finishing.

		YOUNG LADIES	SENIOR LADIES	YOUNG MEN	SENIOR MEN
Slow Waltz	Percent indiv. HRmax [%]	85.4±9.7	95.6±11.2	87.8±6.2	95.8±8.4
30s break 1	Decrease [%]	11.9±6.5	9.0±5.6	10.4±5.2	11.3±5.7
Tango	Percent indiv. HRmax [%]	87.9±11.7	98.4±10.5	91.9±8.8	98.5±10.2
30s break 2	Decrease [%]	12.6±6.1	12.4±6.5	12.6±3.7	9.3±5.6
Viennese W.	Percent indiv. HRmax [%]	95.0±8.9	102.6±7.9	96.9±5.5	104.2±7.1
30s break 3	Decrease [%]	15.0±4.8	11.5±5.2	15.1±4.2	11.6±5.1
Slow Fox.	Percent indiv. HRmax [%]	87.4±10.5	99.5±8.7	88.9±8.2	100.2 ±8.2
30s break 4	Decrease [%]	8.7±3.6	9.7±7.4	8.1±3.3	6.7±3.8
Quickstep	Percent indiv. HRmax [%]	96.1±10.2	105.4±7.4	97.8±5.8	107.5±6.6
after 2min	Decrease [%]	25.3±7.7	22.4±7.1	21.1±6.5	23.5±7.3

Table 2

RPE-ratings for the five dances. The predominant tendency within the RPE- interpretation ranges defined by Borg (2) is marked in bold characters.

	WALTZ		TANGO		VIENNESE WALTZ		SLOW FOXTROTT		QUICKSTEP	
	RPE-Range	Inter-pretation	RPE-Range	Inter-pretation	RPE-Range	Inter-pretation	RPE-Range	Inter-pretation	RPE-Range	Inter-pretation
Young Ladies	10-**11**	fairly light	12-**13**	somewhat hard	14-**16**	hard	**14**-16	hard	14-**16**	hard
Young Men	12-**13**	somewhat hard	**14**-16	hard	14-**16**	hard	**14**-16	hard	**17**-18	very hard
Senior Ladies	10-**11**	fairly light	**12**-13	somewhat hard	**14**-16	hard	**14**-16	hard	**14**-16	hard
Senior Men	**12**-13	somewhat hard	12-**13**	somewhat hard	14-**16**	hard	**14**-16	hard	14-**16**	hard

documented in the BIA (Figure 1a-d).The results for our older couples in turn are widely comparable to our younger dancers and the participants of Vaczi´s study: also, our older dancers of both genders reached maximum heartrate during simulated competition, and the lactate of the ladies was about 6mmol/l, and the males reached about 7mmol/l after finishing the last dance. Thus, our data confirm the earlier observation, that competitive Ballroom Dancing is at least a partially anaerobic exertion for younger and, as shown here, also for older couples.

In addition to this, our results revealed a relevant difference between our younger and older participants: in addition to Vaczi we had asked for the rate of perceived exertion (RPE) according to Borg after every dance and estimated a % HR_{max}-value from the RPE, which was calculated according to the formula of Borg (2,11). The comparison of the measured % HR_{max} from the Holter-ECG with the % HR_{max} estimated from RPE showed, that both, the younger as well as the older couples significantly underestimated their true exertion in nearly all five dances. But, the difference between measured and estimated % HR_{max} was much more pronounced in the older ladies and men. It was remarkable, that although the younger couples tended to self-estimate their exertion more realistic from the third dance, the Viennese Waltz, on, the older ones furthermore significantly underestimated their stress until the end of the final round, although suffering anaerobic lactate levels and heartrates above their individual absolute % HR_{max}. Particular in the final Quickstep the older ladies´ heartrates reached a mean of 177bpm, the men reached even more, 181bpm, which resulted in calculated individual % HR_{max}-values of more than 100% (Figure 3, 4c and 4d).

The obvious discrepancy between the estimates of % HR_{max} from RPE and the calculated % HR_{max} from Holter-ECG may be reflected in two different ways: on one hand, although physical demanding particular for the seniors, the dancing-related effort in this study seemed to be perceived by the dancers in a more likely positive way, which underlines that dancing can be a very motivating sports activity even for elderly. On the other hand, the results should also be discussed with respect to prevention of emergencies particular in senior dancers, since Ballroom Dancing is not only a partially anaerobic exertion, but also challenges maximum heartrate in final rounds. While maximum exertion is not unusual in high performance sports in young athletes and therefore also in elite Ballroom Dancing, one should be aware, that also the senior couples perform on a fully comparable level of exertion as shown in this study. Moreover, and with particular respect to age and general health status of senior couples, their tendency to underestimate their stress throughout all five dances in our final rounds training, needs particular attention in order to avoid risky overload of seniors in competitive Ballroom Dancing.

Discussion

Our study has certain limitations: since the couples danced their final rounds only under training conditions, the situation during a real tournament might be even worse with respect to additional individual situative stress. Moreover, in a real tournament and regardless the age of the couples, the best dancers sometimes have to dance two or three full rounds before they reach the final, when the number of competing couples in the

tournament is high enough. The break between two rounds normally is about 10 to 20 minutes, and therefore it is not ensured, that lactate during the passive recovery between the rounds is back to resting levels (7), when the next round begins (5). Thus, the level of anaerobic stress might increase with the number of rounds, before even entering the most strenuous final.

Conclusion

In summary, final rounds training in competitive ballroom dancing is a strenuous and partially anaerobic exertion for both, younger and seniors, but primarily the seniors tend to underestimate their strain, maybe because of a positively motivating effect of this highly aesthetic, but nevertheless challenging sports activity. Therefore, sports-medical prevention in competitive dancing should become a topic particular for seniors, comparable to other high-performance sport.

Conflict of Interest
The authors have no conflict of interest.

References

(1) **BLANKSBY BA, REIDY PW.** Heart rate and estimated energy expenditure during ballroom dancing. Br J Sports Med. 1988; 22: 57-60. doi:10.1136/bjsm.22.2.57

(2) **BORG G.** Anstrengungsempfinden und körperliche Aktivität. Dtsch Ärztebl 2004; 101: 1016-1021.

(3) **BRIA S, BIANCO M, GALVANI C, PALMIERI V, ZEPPILLI P, FAINA M.** Physiological characteristics of elite sport-dancers. J Sports Med Phys Fitness. 2011; 51: 194-203.

(4) **GELLISH RL, GOSLIN BR, OLSON RE, MCDONALD A, RUSSI GD, MOUDGIL VK.** Longitudinal modeling of the relationship between age and maximal heart rate. Med Sci Sports Exerc. 2007; 39: 822-829. doi:10.1097/mss.0b013e31803349c6

(5) **KASAI N, KOJIMA C, GOTO K.** Metabolic and performance responses to sprint exercise under hypoxia among female athletes. Sports Med Int Open. 2018; 2: 71-78. doi:10.1055/a-0628-6100

(6) **LIIV H, JÜRIMÄE T, MÄESTU J, PURGE P, HANNUS A, JÜRIMÄE J.** Physiological characteristics of elite dancers of different dance styles. Eur J Sport Sci 2014; 14: 429-436. doi:10.1080/17461391.2012.711861

(7) **LUCERTINI F, GERVASI M, D'AMEN G, SISTI D, ROCCHI MBL, STOCCHI V, BENELLI P.** Effect of water-based recovery on blood lactate removal after high-intensity exercise. PLoS ONE. 2017; 12: e0184240. doi:10.1371/journal.pone.0184240

(8) **RODRIGUES-KRAUSE J, FARINHA JB, KRAUSE M, REISCHAK-OLIVEIRA Á.** Effects of dance interventions on cardiovascular risk with ageing: Systematic review and meta-analysis. Complement Ther Med. 2016; 29: 16-28. doi:10.1016/j.ctim.2016.09.004

(9) **RODRIGUES-KRAUSE J, KRAUSE M, REISCHAK-OLIVEIRA Á.** Cardiorespiratory considerations in dance: from classes to performances. J Dance Med Sci Off Publ Int Assoc Dance Med Sci. 2015; 19: 91-102. doi:10.12678/1089-313X.19.3.91

(10) **RODRIGUES-KRAUSE J, KRAUSE M, REISCHAK-OLIVEIRA A.** Dancing for Healthy Aging: Functional and Metabolic Perspectives. Altern Ther Health Med. 2019; 25: 44-63.

(11) **SCHERR J, WOLFARTH B, CHRISTLE JW, PRESSLER A, WAGENPFEIL S, HALLE M.** Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. Eur J Appl Physiol. 2013; 113: 147-155. doi:10.1007/s00421-012-2421-x

(12) **VACZI M, TEKUS E, ATLASZ T, CSELKO A, PINTER G, BALATINCZ D, KAJ M, WILHELM M.** Ballroom dancing is more intensive for the female partners due to their unique hold technique. Physiol Int. 2016; 103: 392-401. doi:10.1556/2060.103.2016.3.11

(13) **WIRTZ N, KLEINOEDER H, BAUCSEK S, MESTER J.** Verlauf der Blutlaktatkonzentration bei aufeinanderfolgenden Kraftbelastungen derselben Muskelgruppe. Schweizerische Zeitschrift für Sportmedizin und Sporttraumatologie. 2012; 60: 26-30.