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PHYSICAL PREPARATION

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Lower extremity muscle fibers activation in two Latin dance modalities

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Mountain biker enjoying nature and open air.
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Abstract
The main purpose of this study was to investigate the muscle activity of different types of muscle fibers between Rumba and Jive dancing styles in eighteen elite DanceSport athletes (mean age: 19.6 ± 3.2 years). Measurements were carried out using surface electromyography (EMG) during performance of the choreography. EMG was recorded in both legs from rectus femoris (RF), biceps femoris (BF), tibialis anterior (TA), and gastrocnemius medialis (GM) and analyzed. In Rumba, the whole activation of RF (median, 115.95; IQR, 36.00 mV) was lower as compared to BF (median, 146.68; IQR, 10.02 mV; $p = .002$) and to GM (median, 149.81; IQR, 85.66 mV; $p = .035$). In Jive, the highest global activation corresponded to the BF (median, 155.40; IQR, 44.89 mV), and differences were statistically significant as compared to the TA activation (median, 123.09; IQR, 51.24 mV; $p = .028$). Significant differences were found between the Rumba and Jive in RF type I fibers ($p \leq .05$), TA type IIa fibers ($p \leq .05$); and GM type IIb fibers ($p \leq .05$) in both male and females. In male dancers, there were differences GM type IIb fibers ($p \leq .05$) and TA type I fibers in females ($p \leq .05$). This study shows experimental evidence of significantly different muscular activation for the lower limb in dances with different tempo. The results of this study provide relevant information for optimizing high-performance training and injury prevention programs, which are key to the success of DanceSport careers.

Keywords: DanceSport, electromyography, fiber types, muscle activation, skeletal muscles.

Introduction

DanceSport is a combination of art, sport and sporting performance. It is performed by couples, allowing them to express emotions and form harmonious movements in response to different types of music (Lukić et al., 2011; Riding et al., 2013; Uzunović et al., 2009; Uzunović & Kostić, 2005).

This sport is made up of three specialities: Latin, standard and "10 dances", the latter being a combination of Standard and Latin dances (WDSF, 2017). Latin dances are mainly characterized by open or semi-open and closed figures, which require a visual connection (Čačković et al., 2012). Dances conforming to the Latin speciality are: the Samba, with a tempo of 50–52 beats per minute (bpm); Cha-cha-cha, with a tempo of 30–32 bpm; Rumba, with a tempo of 25–27 bpm; Pasodoble, with a tempo of 60–62 bpm, and the Jive, with a tempo of 42–44 bpm (FEBD, 2017).

The Rumba is a dance involving highly expressive body rhythm, in which attractive and delicate movements are represented. The fluidity and rhythm of movement in dancers' back muscles and hip action is of great importance (Shang, 2013). In this way, the hips naturally draw a trajectory of movement in an inverted "8" controlled by dancers (Shang, 2013).

The Jive is the most explosive Latin dance and generates a higher heart rate (Bria et al., 2011; Liiv et al., 2014). The basic characteristics of the Jive are a balance between "SWINGy" and "JUMPy", two basic principles that help overall performance of the dance (Dance Comp Review, 2014).

The "SWINGy" is present in each of the steps carried out in the Jive. The body tilts forwards causing lateral displacement by means of hip movement and stays upright during front or back steps. Foot support is mainly achieved by support from the first and second metatarsals (Dance Comp Review, 2014).

In the "JUMPy", the main action is knee flexion while at the same time the abdomen contraction is made, which results in a small jump. This is composed of four phases: step, jump, flight and landing. In the first phase, the step is performed with a small knee flexion, leading to the next phase when extension of the knee is performed, producing the impulse for a jump. This moves into the flight phase and later into the landing, where most support is provided by the first metatarsals with a slight bend of the knees to absorb the impact (Dance Comp Review, 2014).

Surface electromyography is a common, non-invasive technique for analyzing muscle contractions for real-world application (Hermens & Freriks, 1997; Liu et al., 2002). In humans, fast and slow fibers are not physically separated, but evolution has in some way maintained the separation of different types of fibers. Motor units of human muscle are typically categorized into three different groups commonly referred to as slow oxidative or type I (TI); fast oxidative or type IIa (TIIa); and fast glycolytic or type IIb (TIIb) (Von Tscharner & Goepfert, 2006; Brooke & Kaiser, 1970). These groups can be recruited in different proportions for different periods of a movement and can explain at least part of the spectral variability (Von Tscharner & Goepfert, 2003; Wakeling et al., 2001). To analyze data obtained with surface electromyography in variable muscle contractions, techniques have been adopted in time frequency measurements (Kumar et al., 2003). Continuous wavelet transformation (comparison of different frequency techniques over time) produces accurate results with a good representation of time and frequency location (Karlsson et al., 2000).

Scarce evidence exists on DanceSport and, in particularly, on muscle-activity of dancers. Zagorc et al. (2010) used tensiomyography to study the contraction time of DanceSport athletes and observed that the contraction time in muscles like the gastrocnemius varied between genres. Liébana et al. (2017) analyzed EMGs in DanceSport athletes performing the Rumba bolero and observed differences. In this way, found activation differences in women's Rectus Femoris (RF) and Gastrocnemius Medial (GM) muscles associated with the Rumba bolero, as well as in Tibial Anterior (TA) and GM muscles as well as differences between rhythms of various dance genres (Haeufle et al., 2010).

To understand how the complex musculoskeletal system can generate adequate leg strength, knowledge of intrinsic muscle properties is necessary (Haeufle et al., 2010). Therefore, the purpose of our study was to evaluate muscle-activity of the three types of muscle fibers of RF, BF, TA and GM of dancers, comparing the Rumba with the Jive in male and female to stablish specific workouts for these athletes. Expected results would indicate significant differences in activation of the three types of muscle fibers analyzed RF, BF, TA and GM (in both legs, dominant and non-dominant) in the lower limbs of dancers, comparing the Rumba with the Jive and between genders.

Materials and Methods

Participants

Participants consisted of 18 DanceSport athletes (nine couples). They are all category A dancers (the top category) with 10.44 ± 3.51 years of dance experience and who are specialists in "10 dances" or Latin dances (see table 2).

The inclusion criteria stipulated that participants had to be active during the study and over eighteen years old and conform to the 10 dances or Latin modality; participants needed to have been injury-free during the previous year and to have been dancing in category A for at least a year with the same partner. Six dance schools were contacted, which might be interested in participating in the assessments. Out of a total of 10 couples who fulfilled the inclusion criteria, nine couples were measured, i.e., 18 subjects, all of them with right dominance. One couple was excluded from measurements due to scheduling problems and these dancers subsequently dissolved their partnership.

Procedures

Dancers were asked not to do any physical exercise in the 24 hours prior to the research session. During the session, height measurements (using a SECA 709 7021994 measuring rod; Seca GmbH & Co. KG., Germany) and anthropometrical data (weight and body-mass index) were collected using bioelectrical impedance (Tanita BC-418 MA Segmental Body Composition Analyzer; Tanita Corporation, Japan).

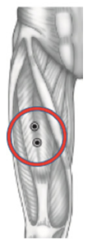
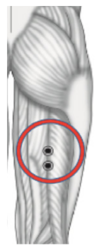
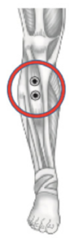
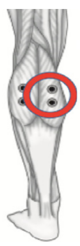
To compile the data with electromyography (EMG), the standard protocol (see Table 1) was followed in order to prepare the participants' skin and placing the electrodes (Torrence & Compo, 1998; Welch, 1967).

Later, the participants carried out an identic RAMP warm-up adaptation that consisted in integrating joint mobility in the ankles, knees, hips and shoulders, followed by specific movements in pairs without music, and continued activation by squats and planks, ending with the couples developing a dance to music (Jeffreys, 2007). Measurements were performed using surface electromyography of muscle activation during all competitive choreographies (120 s each type of dance), prepared and performed by the dancers (Mega Electronics Ltd., Kuopio, Finland).

There are previous works with pre-established choreographies (Liébana et al., 2018), and with this work we intend to measure activation in an ecological context, approaching the real context of competition.

The study was approved by the Ethics Review Board of the Catholic University of Valencia San Vicente Mártir,

Table 1
Placement of electrodes and coding of muscles and legs.

Muscle	Code left or right	Placement of electrodes	Figure location electrodes
Rectus femoris	RF1 Right RF2 Left	Halfway between the knee and the iliac spine; the electrode is, therefore, placed between these two areas.	
Biceps femoris	BF1 Right BF2 Left	The ischium must be located, and the distance between the ischium and the popliteal fossa must be measured. The electrodes are then placed ⅔ of the way down from the ischium.	
Tibialis anterior	TA1 Right TA2 Left	Parallel to the axis of the tibia, approximately in the first ⅓, between the knee and ankle.	
Gastrocnemius medialis	GM1 Right GM2 Left	The electrodes are placed ⅓ of the way down from the popliteal fossa, 2 cm from the midline of the muscle.	

Note. Figures adapted from Criswell & Cram (2011).

with the code UCV/2015-2016/60, and is in accordance with the Declaration of Helsinki. Participants were aware of the purpose of the study, and all were provided with a written informed consent.

Data processing

All EMG measurements were collected by Mega WBA sensors with a 1,000 Hz sampling rate, 20-500 Hz sensor frequency band-pass, Kendall 200 foam electrodes with conductive adhesive hydrogel (placed with a maximum inter-electrode distance of 20 mm) and were compiled using Megawin 3.1 software (Mega Electronics Ltd., Kuopio, Finland). They were then transferred to an ASCII file for further analysis. Data extracted from muscle activation are given in millivolts (mV). The file was transformed to .m for analysis using Matlab.

Data processing was initiated using Matlab R2017b, which automatically selects the central seconds of each exercise. The signal was filtered using a band-pass filter to establish the minimal values with a limit of 20 Hz and maximum values of 400 Hz. The root mean square (RMS) was obtained. A Fourier transform was carried out using the Fast Fourier Transform (Welch, 1967), indicating the spectrum of average power, which will allow an estimation of the spectral density. For this purpose, Welch's periodogram was used with a 1024 Hamming window of length, with the intention of estimating the spectral density (Welch, 1967). In this method, fragmentation of the time series is carried out, calculating in this way a modified periodogram for each of the segments. Once the average is calculated, this process facilitates estimation of the spectral density. The Welch method is an improvement to the standard method of the periodogram, since it performs a reduction of noise in the estimated power spectrum. However, a problem arises with this method. In order to correct this, a time-frequency analysis was applied, where a window of fixed length moves along the signal in order to relate the frequencies with time and the frequencies can be evaluated in each window.

After this, a non-stationary time series analysis is applied by means of the wavelet transform (Torrence & Compo, 1998), a method that can analyze the time-scale domain signal. This is a temporal series formed by families of functions defined temporally and spatially, which are produced by scaling and translation of a function called the base function. The scalogram consists of a power spectrum averaged for the different frequencies or scales, granted at each time value (Torrence & Compo, 1998).

The wavelet transform is divided into two variables: the continuous wavelet transform detects patterns or modifications along the temporal evolution of the signal at different scales; the discrete wavelet transform is obtained by the decomposition of the signal in different zones of the frequency spectrum, followed by data filtering to obtain the wavelet coefficients. Filtering occurs in relation to approximation, detail and the filters of low pass (5 Hz) and high pass (250 Hz). These results are the decomposition of the global signal into orthogonal signals that allow splitting of the signals in each of the frequency bands. In this case, three bands were fixed: the first, < 70 Hz; the second, 70-125 Hz, and the last, 126-250 Hz (Torrence & Compo, 1998).

Statistical analysis

The SPSS 22.0 statistical package (IBM, Chicago, IL) was used to analyze the data. Descriptive characteristics of anthropometry are presented as means and standard deviations (SD). Due to the limited sample size (9 couples), nonparametric tests were recommended to compare the quantitative variables. Changes in muscle activation between the two dance modalities were assessed with the Wilcoxon rank test. Given the possible variability of EMG measurements in the participants, values were presented as medians and interquartile ranges (IQR). Comparisons of quantitative variables between male and female dancers were assessed with the Mann-Whitney test. The Z value was also indicated. For all main effects and interactions, a confidence level of .05 was adopted.

Results

Descriptive anthropometric characteristics of the sample are presented in Table 2. There were no significative differences between male and female dancers in the anthropometric variables (Table 2).

Table 2
Anthropometric characteristics.

	Men (*n* = 9)		Women (*n* = 9)		Mann-Whitney	
	Mean ± SD	95 % CI	Mean ± SD	95 % CI	Z	*p*
Age (years)	20.4 ± 3.7	17.5 - 23.3	18.8 ± 2.5	16.8 - 20.7	-1.333	.190
Height (cm)	166.7 ± 10.8	158.4 - 175.1	170.0 ± 8.0	163.8 - 176.2	-.710	.478
Weight (kg)	62.2 ± 11.7	53.1 - 71.2	60.2 ± 9.4	52.9 - 67.4	-.309	.757
BMI	22.1 ± 1.8	20.8 - 23.5	20.7 ± 1.9	19.2 - 22.2	-1.370	.171

Note. SD: Standard deviation

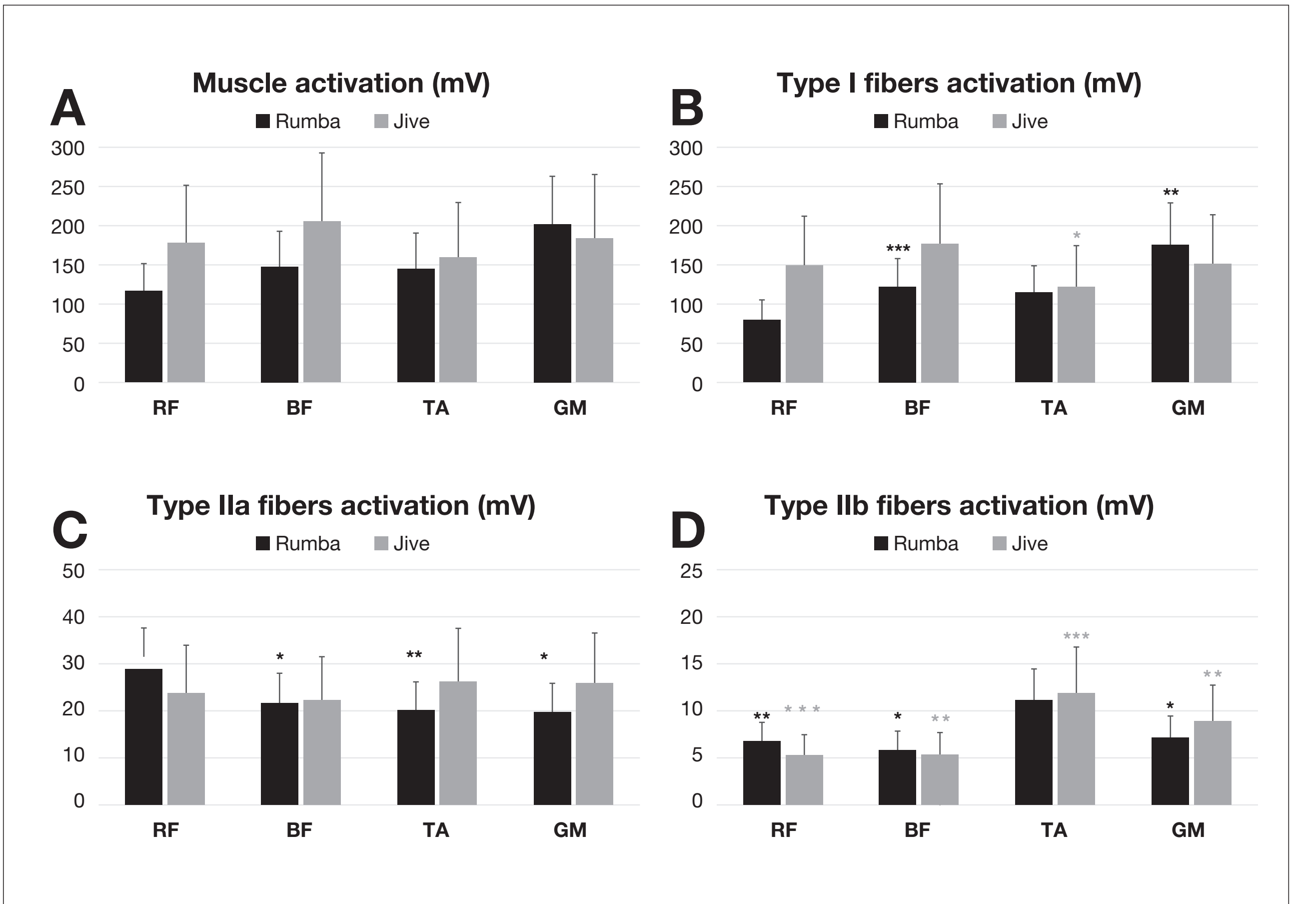
Considering EMG activation of all muscle fibers together in the different muscles analyzed, Rumba dance modality showed less activation than Jive in the muscles of the proximal aspect of the lower extremity (RF and BF), although there were no differences between the two dance modalities (Figure 1A). In Rumba, the activation of RF (median, 115.95; IQR, 36.00 mV) was lower as compared to BF (median, 146.68; IQR, 10.02 mV; p = .002) and to GM (median, 149.81; IQR, 85.66 mV; p = .035). GM showed the highest muscle activation in Rumba dance. In Jive, the highest activation corresponded to the BF (median, 155.40; IQR, 44.89 mV), and differences were statistically significant as compared to the TA activation (median, 123.09; IQR, 51.24 mV; p = .028). There were no differences between dominant and non-dominant leg in global EMG activation of the muscles during the two dance modalities.

In figure 1, B, C and D show a more detailed comparison between activation of different fiber types in the muscles evaluated at the dominant leg in relation to the dance modality. In Rumba, the Type I fibers activation of RF was significantly lower than BF (z = –3.201; p = .001) and GM (z = –2.635; p = .008). Furthermore, GM showed the highest type I fiber muscle activation in Rumba dance. In Jive, the highest activation corresponded to the BF (median, 124.05; IQR, 55.35 mV), and differences were statistically significant as compared to the TA activation (median, 85.90; IQR, 35.52 mV; p = .028).

Concerning type IIa fibers, RF muscle showed higher activation in Rumba than in Jive. In Rumba, RF activation was significantly higher than BF (z = –2.3301; p = .020), TA (z = –2.809; p = .005), and GM (z = –2.243; p = .025) (Fig. 1C).

The activation of type IIb fibers was very low in all muscles studied. In both dance modalities the highest activation was found in TA (Figure 1D). In Rumba, TA activation showed statistically significant differences as compared to RF (z = –2.940; p = .003), BF (z = –2.461; p = .014), and GM (z = -2.025; p = .043). In Jive, TA activation also showed statistically significant differences as compared to RF (z = –3.201; p = .001), and BF (z = –3.157; p = .002). In Jive, there were also differences between RF and GM activation (z = –2.765; p = .006), and between BF and GM (z = –3.157; p = .002).

Figure 1
Recording activation.



Note. *p < .05; **p < .01; ***p = .001. A: EMG recording global activation of the different muscles analyzed in the dominant leg; B: activation of type I fibers; C: activation of type IIa fibers; D: activation of type IIb fibers in the dominant leg. (RF: Rectus Femoris; BF: Biceps Femoris; TA: Tibialis Anterior; GM: Gastrocnemius Medialis).

Descriptive data, relating to the activation of the different types of muscle fibers in both dominant and non-dominant leg during the two dance modalities, are presented in Table 3. Regarding type I muscle fibers, Rumba dance showed less activation than Jive in RF and BF muscles of the dominant leg, but differences were only significant for RF ($p = .022$). In type IIa fibers, TA and GM of the dominant leg in Jive showed higher activation than in Rumba, but differences were only statistically significant in TA ($p = .002$). The activation of type IIb fibers was very low in all muscles studied. Differences between Rumba and Jive were only detected in the GM of the non-dominant leg ($p = .016$). When dominant and non-dominant legs were compared within each dance modality, there were only differences in the activation of type I fibers of the GM, which were higher in the dominant leg in Rumba dance ($p = .006$).

In Jive dance, there were no differences in the activation of the different muscles analyzed. Distal muscles (TA and GM) were more activated in Jive than in Rumba. In Jive, the highest type IIa fibers activation was detected in GM at both sides (Table 3).

Table 3
Rumba - Jive differences between dances and type of fibers.

Muscle and fiber	RUMBA		JIVE		Wilcoxon rank test	
	Median (IQR)	95 % CI	Median (IQR)	95 % CI	Z	p
Dominant leg						
RF1_TI	79.09 (40.73)	66.30 - 93.88	99.38 (47.94)	80.92 - 216.57	-2.286	.022*
RF1_TIIa	30.18 (4.00)	22.37 - 35.86	28.34 (16.98)	18.75 - 28.94	-1.502	.133
RF1_TIIb	7.24 (4.01)	5.07 - 8.39	5.30 (3.00)	4.06 - 6.49	-1.633	.102
BF1_TI	118.65 (20.27)	100.61 - 139.78	124.05 (55.35)	108.20 - 249.55	-.762	.446
BF1_TIIa	24.11 (3.67)	18.65 - 24.61	24.02 (10.19)	18.19 - 26.35	-1.111	.267
BF1_TIIb	5.29 (2.62)	3.63 - 8.30	5.48 (3.81)	4.16 - 6.55	-1.372	.170
TA1_TI	79.44(138.13)	65.63 - 163.07	85.90 (35.52)	41.83 - 205.02	-.806	.420
TA1_TIIa	24.33 (13.00)	15.39 - 24.94	27.52 (7.90)	21.24 - 31.63	-3.027	.002**
TA1_TIIb	11.47 (6.61)	8.45 - 13.78	11.86 (5.98)	8.26 - 15.39	-1.111	.267
GM1_TI	122.62 (95.24)	91.93 - 259.49	98.12 (42.77)	66.11 - 235.37	-.457	.647
GM1_TIIa	22.72 (14.74)	14.39 - 25.66	27.46 (10.32)	20.34 - 31.74	-1.677	.094
GM1_TIIb	7.22 (6.17)	4.86 - 9.62	8.11 (4.17)	6.83 - 11.21	-1.502	.133
Non-dominant leg						
RF2_TI	81.60 (23.77)	73.34 - 107.23	98.30 (58.09)	73.90 - 144.18	-1.459	.145
RF2_TIIa	29.86 (4.70)	21.94 - 34.56	28.98 (8.89)	22.45 - 33.50	-.675	.500
RF2_TIIb	6.67 (3.04)	5.20 - 8.78	5.19 (4.10)	4.88 - 7.55	-1.198	.231
BF2_TI	128.27 (39.77)	112.54 - 203.61	129.55 (45.10)	104.49 - 295.01	-.936	.349
BF2_TIIa	21.70 (8.66)	15.78 - 24.35	22.07 (8.56)	16.25 - 24.25	-.327	.744
BF2_TIIb	4.82 (3.16)	3.49 - 6.41	4.99 (3.67)	3.59 - 6.39	-1.28	.199
TA2_TI	65.50 (75.72)	39.15 - 179.11	82.08 (52.91)	49.92 - 200.74	-1.023	.306
TA2_TIIa	23.60 (10.69)	15.35 - 26.20	23.34 (12.11)	16.10 - 28.92	-1.241	.215
TA2_TIIb	9.91 (8.58)	6.77 - 12.41	9.77 (7.18)	6.89 - 11.75	-.240	.811
GM2_TI	84.17 (40.96)	65.33 - 105.32	84.80 (100.03)	64.85 - 222.78	-1.851	.064
GM2_TIIa	23.17 (10.25)	15.61 - 26.90	24.92 (10.31)	20.23 - 33.15	-1.285	.199
GM2_TIIb	8.52 (5.83)	5.98 - 10.89	11.02 (7.76)	8.55 - 13.35	-2.417	.016*

Note. *$p < .05$; **$p < .01$; RF1_TI = Rectus femoris (right), fiber type I; RF1_TIIa = Rectus femoris (right), fiber type IIa; RF1_TIIb = Rectus femoris (right), fiber type IIb; BF1_TI = Biceps femoris (right), fiber type I; BF1_TIIa = Biceps femoris (right), fiber type IIa; BF1_TIIb = Biceps femoris (right), fiber type IIb; TA1_TI = Tibialis Anterior (right), fiber type I; TA1_TIIa = Tibialis Anterior (right), fiber type IIa; TA1_TIIb = Tibialis Anterior (right), fiber type IIb; GM1_TI = Gastrocnemius Medial (right), fiber type I; GM1_TIIa = Gastrocnemius Medial (right), fiber type IIa; GM1_TIIb = Gastrocnemius Medial (right), fiber type IIb; RF2_TI = Rectus femoris (left), fiber type I; RF2_TIIa = Rectus femoris (left), fiber type IIa; RF2_TIIb = Rectus femoris (left), fiber type IIb; BF2_TI = Biceps femoris (left), fiber type I; BF2_TIIa = Biceps femoris (left), fiber type IIa; BF2_TIIb = Biceps femoris (left), fiber type IIb; TA2_TI = Tibialis Anterior (left), fiber type I; TA2_TIIa = Tibialis Anterior (left), fiber type IIa; TA2_TIIb = Tibialis Anterior (left), fiber type IIb; GM2_TI = Gastrocnemius Medial (left), fiber type I; GM2_TIIa = Gastrocnemius Medial (left), fiber type IIa; GM2_TIIb = Gastrocnemius Medial (left), fiber type IIb.

Descriptive data relating to fiber types for the Rumba and Jive dancing in both sexes are shown in Table 4. Significant differences were obtained for men and for women in TA type I fibers in both Rumba and Jive at the dominant leg ($p = .028$). In females, there were significant differences TA non-dominant activation between Rumba and Jive ($p = .038$). When male and female dancers were compared within each modality, differences in EMG activation were only found in the GM of the dominant leg during Rumba (Table 4). Males showed a lower activation of GM type I fibers ($p = .019$) and higher activation of GM type IIa fibers ($p = .014$) than females.

Discussion

Dancers in general and DanceSport in particular have not been studied in depth, and there is a notable lack of information on the behavior of muscle fibers during this sport. The importance of the present study lies in the significant differences identified between the Rumba and Jive, facilitating the programming and planning of neuromuscular training according to our findings. Although we are aware of the limitations due to the small number of the sample, since it is a minority sport. These dances have key differences in technique, rhythm and tempo, but the fact that there are clear differences in muscle

Table 4
Data relating to fiber types for the Rumba and Jive between genders.

Muscle and fiber	Mean (SD)		Man		Mean (SD)		Woman	
	Rumba Man Median (IQR)	Jive Man Median (IQR)	Z	*p*	Rumba Woman Median (IQR)	Jive woman Median (IQR)	Z	*p*
Dominant leg								
RF1_TI	83.02 (44.65)	100.05 (106.13)	. -1.48	.139	75.20 (29.26)	98.13 (67.49)	-1.83	.066
RF1_TIIa	29.20 (4.06)	28.35 (13.28)	-.415	.678	31.41 (3.70)	27.51 (17.07)	.67	.086
RF1_TIIb	5.63 (4.03)	4.78 (2.75)	-.533	.594	7.92 (4.13)	5.48 (4.57)	-1.362	.173
BF1_TI	113.69 (24.37)	112.72 (38.13)	. -1.599	.110	124.30 (33.60)	129.60 (200.89)	-.059	.953
BF1_TIIa	24.16 (2.59)	25.13 (7.38)	. -1.836	.066	22.88 (5.33)	22.54 (17.45)	-.296	.767
BF1_TIIb	5.46 (2.54)	5.77 (3.50)	-.415	.678	5.11 (3.76)	5.46 (4.88)	-1.481	.139
TA1_TI	73.86 (143.55)	79.46 (29.96)	-2.192	.028*	85.01 (144.81)	87.87 (74.58)	-2.192	.028*
TA1_TIIa	24.93 (19.17)	27.90 (7.12)	-1.244	.214	23.21 (11.13)	27.14 (12.49)	-.415	.678
TA1_TIIb	11.49 (12.26)	11.87 (6.12)	-.652	.515	11.45 (5.97)	11.85 (7.12)	-1.244	.214
GM1_TI	91.64 (44.20)	98.57 (51.51)	-1.955	.051	164.27 (241.70)	97.67 (95.12)	-1.362	.173
GM1_TIIa	25.08 (5.64)	27.72 (8.17)	-.770	.441	13.12 (18.84)	23.30 (16.36)	-1.362	.173
GM1_TIIb	8.86 (4.56)	9.96 (4.97)	-.652	.515	4.82 (9.19)	6.92 (4.96)	-1.244	.214
Non-dominant leg								
RF2_TI	81.04 (31.19)	81.63 (51.21)	-.059	.953	82.16 (49.64)	105.14 (52.78)	-1.955	.051
RF2_TIIa	29.94 (8.35)	31.86 (7.28)	-.178	.859	29.49 (10.02)	26.37 (14.04)	-.652	.515
RF2_TIIb	5.92 (3.99)	5.32 (4.29)	-.889	.374	6.84 (2.38)	4.95 (4.46)	-.652	.515
BF2_TI	123.78 (46.23)	120.52 (43.00)	-.415	.678	137.56 (119.12)	147.85 (281.04)	-.889	.374
BF2_TIIa	21.88 (7.42)	24.93 (± 5.05)	-1.362	.173	21.60 (17.06)	19.97 (15.20)	-1.007	.314
BF2_TIIb	4.96 (3.10)	4.87 (2.32)	-.059	.953	4.49 (4.52)	4.92 (7.14)	-1.362	.173
TA2_TI	65.19 (141.56)	76.59 (47.97)	-.770	.441	65.82 (49.02)	90.64 (124.99)	-2.073	.038*
TA2_TIIa	23.62 (27.16)	23.15 (26.98)	-.533	.594	23.58 (6.19)	23.53 (11.89)	-1.481	.139
TA2_TIIb	11.89 (12.26)	10.95 (12.23)	-.296	.767	9.09 (8.73)	8.86 (4.29)	-.059	.953
GM2_TI	84.38 (23.73)	100.44 (78.84)	-1.007	.314	73.56 (69.00)	87.55 (210.68)	-1.481	.139
GM2_TIIa	26.62 (8.26)	27.59 (18.90)	-.415	.678	20.08 (23.29)	21.86 (11.99)	-1.599	.110
GM2_TIIb	9.00 (3.27)	14.10 (4.41)	-2.666	.008**	5.92 (14.77)	8.31 (7.96)	-.533	.594

Note. *$p < .05$; **$p < .01$; ***$p < .001$

activation must also be taken into account in the development of training sessions to optimize performance and reduce the risk of injury.

Technique, rhythm and movements associated with the Rumba are slower than in the Jive. In the Rumba, particular aesthetics are sought, so that its technique favors extension of the lower limbs (Shang, 2013). In contrast, the Jive has characteristics similar to hopping with its consecutive jumps and kicks. This exercise combines speed and strength to produce an explosive-reactive movement (Cappa & Behm, 2013). These exercises involve a circle of eccentric (stretch) and concentric (shortening) muscle contractions, generally using the body as an overload and generating a stretch-shortening cycle (SSC) (Cappa & Behm, 2013). For a muscle action to be classified as a stretch-shortening cycle during rebounding activity, the muscular activation pattern must include preactivation prior to contact with the ground, a fast eccentric action, and an immediate and rapid transition between the eccentric and concentric phases (Komi, 2000). For this reason, there are significant differences between the Rumba and Jive in RF1_TI, TA1_TIIa and GM2_TIIb on the non-dominant leg. As with hopping, in Jive, the hamstring muscles and quadriceps muscles must be active at the same time to create stability (Wibawa et al., 2016).

The TA is a muscle which is activated not only in dorsiflexion of the foot but also for controlling pronation, so that in the Jive it would be acting eccentrically to support both movements (Cappa & Behm, 2013). Hence, differences are mainly found in TA1_TIIa between the Rumba and Jive. The fibers of TA1_TIIa are activated in short, high intensity movements as this muscle provides support by eccentric braking activation. This activation is also favored for support and when dancers are performing a landing technique using the first and second metatarsals (Dance Comp Review, 2014).

Significant differences were also found between the Rumba and Jive in relation to GM2_TIIb. This may be due to the SSC work of this muscle, since a Jive technique favors the continuous performance of fast jumps and kicks, thus generating plyometric work and the performance of a stretch-shortening cycle (Cappa & Behm, 2013). Nicol et al. (2006) highlight in their work that the gastrocnemius reacts differently on landing following a jump. If the jump is small, the fibers of the gastrocnemius muscle tend mainly to shorten for braking. If the jump is high and requires significant braking, the muscle fibers tend to lengthen. This is due to the lower resistance to stretching due to the possible release of cross bridges (Nicol et al., 2006). The impact load determines the behavior of the fascicle in a specific muscle and the intensity of the effort after the braking phase has some influence on this interaction by affecting the tendon recoil in the final thrust (Nicol et al., 2006).

On the other hand, our results show differences in muscle activation between men and women. These data would be in line with those obtained in the study by Liébana et al. (2017). Differences in muscle activation between genders were observed in the Tibialis Anterior and Gastrocnemius muscles, showing that activations between men and women were different (Haeufle et al., 2010). This may be due to both the differences between the women's and men's steps, and the marked difference between heels in men's and women's dance shoes, and consequently different active forces are generated in the legs by the muscles. Hill (1938) described and separated the intrinsic properties of a single muscle, represented by a serial elastic element and a contractile element with force-length and force-velocity relations. Muscular properties can compensate for disturbances and facilitate the convergence of dynamic and explosive movements. The intrinsic muscle properties represented by the force-length-velocity function in Hill-type muscle models act as a zero-delay peripheral feedback system (Haeufle et al., 2010).

The differences in muscle activation between the types of fibers, muscles, genders and dances observed in our study would demonstrate the need for individualized and planned training for each type of dance and partner (male vs. female). Hence the need for specific training for dancers, addressing the type of strength worked, mobility training, technique and motor control. These factors are of great importance to prevent injuries and achieve maximum athletic performance.

Regarding the data shown in this study, it is worth noting the limitations in terms of the sample, since it is a low number of participants compared to other research, but representative of the number of participants in the Spanish championship, taking into account that DanceSport is a minority sport.

Conclusions

The results of this study provide experimental evidence of significantly different muscle activations for the lower extremity as a function of gender and dance modality. Significant differences in activation as a function of fiber type were found between Rumba and Jive. From a clinical perspective, our findings can help coaches and sports physicians understand the specific sports profile of elite dancers. Knowledge regarding muscle function, activity, and balance is extremely important to optimize the high level of performance of these athletes and to support injury-prevention programs, which are key to maximizing their athletic success. These results are a first step in providing reference values for muscles fibers involved in dance sport movements that can contribute to the design of exercises to aid both sports performance and injury prevention. By carrying out this type of analysis using wavelets, it has been possible to observe how this analysis is sensitive and shows consistent results, considering the limitations of the study at all time. The wavelets can be used for analysis of movements with similar characteristics (Cappa & Behm, 2013). This analysis allows us to understand the muscular demands of different types of dance. Thus, for the correct development of the Jive, plyometric work is important, with a shortening-stretching cycle. In addition, to minimize muscle imbalance between the posterior and anterior chain, as well as asymmetry between the dominant and non-dominant leg, strength work would be recommended.

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