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Biomechanics and Physiology in top level Pole Dancers. A case study

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Abstract: The aim of this study was to investigate the physical and physiological demands of three top-level pole dancers' performances during a simulated competition. Three elite pole dancers, participated in the study. Physical data pertaining to the accelerations and the rotational values were collected. A complete video footage was recorded. Blood Pressure, Heart Rates, Blood Lactate concentrations were recorded during the performance. Before and after the simulated competitions some postural stability tests were also performed. Accelerations along the vertical axis reached ≈2G and rotational movements around the pole, reached ≈400°/s. Blood Pressure values ranged from 120/75 before and to 145/58 mmHg at the end of performance, respectively. Heart Rates reached a mean peak value of ≈114% of the Maximal Estimated Heart Rates (HR_{max}) and a mean HR_{max}% of 74.59±8.82% during the simulated competition. Blood Lactate concentration ranged from 11.43±2.13 to 10.63±1.65 mmol/L measured at 1 min and 5 min after the completion of the competition, respectively. Postural effects were observed on balance, after the performances. The results of this case study confirm that the Pole Dancing requires heavy physiological and physical demands on the performers. Specific training routines should be designed in order to cope efficiently with this physical activity.

Keywords: Talent; Performing arts; Performance analysis; Performance model; Simulated competition; Testing; Postural stability

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Introduction

In the last few years, the Pole Dancing-or Pole Dance - is gaining more and more relevance in various entertainment shows or sporting-related events. It is not a coincidence that many television talent-shows, focused on the discovery of new talents in the field of music and choreography, are including the Pole Dance performers, probably relying on the intrinsic spectacular nature and elegance of this old and noble performing art.

Pole Dance (PD) is the art of performing a sequence of plastic figures, both statically and dynamically, with a musical background, being in suspension on a vertical pole by the sole strength of the handgrip, and using the friction forces of the different parts of the body in contact to the pole. The aim of the performance is thus to reach and keep harmoniously these figures, evolving to the subsequent ones, according to the schemes properly designed within the frame of the rules of the different agencies governing this discipline worldwide [1]. As per other similar sport disciplines (i.e. gymnastics, diving, sport dancing, etc.) a panel of judges or referees assesses the overall performance, assigning a final score for each performer athlete.

Probably due to the inclusion of this discipline in many television shows that reach a growing audience, we are seeing in recent years to a boom of popularity of this sport, which attracts more and more practitioners. Although the growing popularity of pole dance as a leisure-time activity of people of all ages, the problem of physical and physiological effects of exercising on the pole is still little considered in the scientific literature, especially when referred to the top-level athletes [2]. To our knowledge, no scientific papers were published on this topic so far, thus the aim of this case study is to report a preliminary research we carried out on three top-level pole dancers with the purpose to provide a first model of performance under a physical and physiological standpoint. Other individual sports, such as gymnastics, subjected to the quality assessment by a jury, [3-8] have been studied to define biomechanical and physiological models of performance. These models are considered of fundamental relevance by the coaches, in order to design training sessions consistent with the demands of the performance.

Our main hypothesis is that pole dancing poses important requests from the physiological point of view (comparable to what found in gymnastics), such as to define this discipline as one with high metabolic and neuro-muscular demands. The main aim of our study is to provide the insiders with a first biomechanical and physiological model of pole dancing, derived from the performance of top-level athletes. Thus, the aim of this experimental phase was to measure some physical and physiological parameters of three top level Pole Dancers' performance, simulating a regular competition in our laboratory [9]. The goal was to determine a performance model, through the study of those parameters most commonly measured as expressions of internal and external load, respectively [Blood Pressure (BP), Blood Lactate concentration (Bla-), Heart Rate (HR) values; the linear accelerations and the angular velocity (a_l and v_a) and some segmental relationships] [6-12]. We also decided to investigate, through stabilometric testing, some components of the postural stability [13] of the dancers, before and after their performance, to see if and how these components were affected during a competition, considering the rotational forces involved in these performances and their possible influences on the vestibular apparatus of the dancers.

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Materials and Methods

Subjects

Three top-level pole dancers volunteered to participate in this study, carried out in September 2017. Some relevant biometrics are reported in table 1.

Table 1: Biometrics of the pole dancers participating to the study

Dancer	Gender	Age (yrs)	Height (m)	Body weight (kg)	BMI (kg/m^2)	HRmax[1] (bpm)
PD1	Female	24	1.64	48	17.8	192
PD2	Female	30	1.60	52	20.3	187
PD3	Male	35	1.71	71	24.3	184

[1]estimated values; PD=Pole Dancer

They are top-level Pole Dancers competing in various contests held at the international level and performing in non-competitive exhibitions also, aimed at presenting this discipline in different contexts. Their experiences in this discipline began several years ago (mean 6 years), coming from previous careers of dancers and gymnasts.

Their usual training schedules consist of six/eight sessions per week of about 2 hours each. Usually their training consists of resistance training, flexibility and agility, dancing technique, choreography, and the specific training on the pole. They provided a written informed consent, after familiarization and explanation of the benefit and risks involved in the procedures of this study. They were informed that they were free to withdraw from the study at any time without penalty. The Institutional Research Board (the Ethical Committee of the School of Sports and Exercise Science, University of Rome "Tor Vergata", Faculty of Medicine and Surgery) approved our research protocol and provided clearance for the procedures before the commencement of this study. All procedures were carried out in accordance with the Declaration of Helsinki of the World Medical Association as regards of the conduct of clinical research.

Procedures

To study the physical and physiological demands of top-level Pole Dancing, we simulated a real competition in our laboratory, (see **Picture 1**) asking the Dancers to provide a typical PD performance, lasting three minutes and thirty seconds, in accordance with the official rules of the discipline. They completed a sequence (lasting three minutes) on the pole, as per official protocol, and spent thirty seconds of choreography *"feet on the ground"*, as an introduction and ending phase of the trial, respectively.

A panel of expert referees (n=4) assessed these simulations by the means of video analysis and have given a score, in accordance with the official rules of the discipline, of 10.3±0.58 points out of 11 as a mean.

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Picture 1: Pole Dance: technical movements performed during the simulated competitions and video recorded to be assessed by the referees.

The temperature in this indoor laboratory was ≈ 19°C. This temperature should be considered as optimal for the PD, since sweating is considered a limiting factor by these performers, who based most of their techniques on the ability to control the grip of the hands and/or the friction forces of other parts of the body with the pole.

The participants were advised to maintain a regular diet during the day before testing (i.e., 60, 25, and 15% of carbohydrates, fat, and protein, respectively) and to refrain from smoking and caffeinated drinks during the 2 hours preceding testing. To avoid hypohydration, they were allowed to drink water according to their personal needs.

The women athletes reported to be about one and two weeks after the end of their menstrual cycle, respectively. To estimate the maximal heart rates (HR_{max}) of the dancers we computed these values applying the formula [1] proposed by Tanaka et al. [14].

[Estimated HRmax=208-0.7xage**]**
[formula 1]

After the preliminary procedures regarding the instrumentation (i.e. the positioning of the passive markers on the body, wearing the chest belt and the accelerometer device) and the preliminary collection of some basal physiological parameters, (Blood Pressure, Heart Rate, Blood Lactate), the participants warmed up for about 20 minutes, performing their habitual routines (5' jogging, stretching routine, specific movements and drills on the pole).

Instrumentation

As already reported, the physiological demands of these performances were considered and measured through the heart rates (HR), the blood pressures (BP) and the blood lactate (Bla) concentrations [2]. The pole dancers wore a HR monitor chest belt (SUUNTO, Valimotie, Vanta, Finland), sampling each second, during all the trial. The Blood Pressure was measured by the means of the Marshall *mb02* electronic device (Omron Matsusaka Co., Japan). Capillary blood samples were drawn from the ear lobes of the Pole Dancers using a sterile lancet (Accu-Check Softclix, Roche-5µ) immediately after the warm up, at the end of the performance (within 1 minute) and then at 3,5,9 and 12 minutes after the completion of the performance. Blood samples were analysed for blood lactate (BLa^-) concentration by the means of LactatePro LT1710 Analyzer, (Arkray, Japan). To collect the data referring to the accelerations and to the angular velocity of the Centre of the Mass of the pole dancers the Sensorize FreeSense™ device was used [15].

This portable device, a tri-axial accelerometer integrated with three gyroscopes, sampling at 200 Hz, was worn by the pole dancers and it was fixed back to the lumbar region of the athletes, in accordance with the manufacturer instructions. To evaluate the postural stability of the pole dancers, before and immediately after the simulated competitions, we analyzed the displacement of the projections on the ground of the center of pressure (COP) of the body by the means of a computerized detection system [16]. An Electronic Baropodometer, [Stabylo-Multisensor (Diagnostic Support, Italy), consisting of a platform, reinforced at the base by a metal plate with a thickness of 0.005 m and covered by sheets of NOENE-thickness of 0.003 m-whose dimensions were 0.8 m (length) and 0.4 m (width) with 12800 platinum resistive electronic sensors] was used. To analyze the collected data we used the software *Milletrix*.

The parameters taken into consideration were:

- The Ellipse or Surface Area (mm^2), which allows to evaluate the amplitude of the oscillations;
- The Sway Path (mm) which is the total length of the COP trajectory projected on the ground;
- The Average speed (mm/s) which is the length of the Sway Path divided by the execution time of the test (51.2 s in Bipodalic testing; 5 s in Monopodalic testing).

Postural testing protocol was:

- Bipodalic Stabilometry in a standing upright position with eyes open, barefoot, before and after the simulated competition. The test lasted 51.2 s.
- Monopodalic Stabilometry (left and right footed), with eyes open and eyes closed, barefoot, before and after the simulated competition. The test lasted 5 s

These measures were taken in a quiet side of our laboratory, screened for this purpose. The platform was set at a distance of 2 m from the closer wall [17].

The complete video footage of the performances were recorded, by the means of several video camera, recording with different sampling rates and from different angles:

- 2 cameras Casio Exilim FX-H20 (sampling at 210 fps) set at right angles to each other;
- 1 camera Canon XM1 (sampling at 25 fps)
- 1 camera Sony Handycam (sampling at 25 fps)

The video data were then processed using the software “DartFish 6.5” and Kinovea 8.25.

All this video data were then analyzed by the referees in order to assess the quality of the performances. To check the Rating of Perceived Exertion (RPE) we used the Borg’s Scale CR-10, [18-22] where a score of ten represented the highest intensity, and a score of zero was the lowest intensity.

Statistical Analyses

Being a case study with a reduced sample size, the data are presented as absolute values, when the parameters are recorded once (i.e. Bla^- concentration). In multiple measurements performed over time during the simulated competition (i.e. the percentage reached of the maximal Heart Rate-$\%HR_{max}$) we present those values as mean, standard deviation (M±SD), standard error for the mean (SEM) and confidence interval for the mean (C.I. 95%). To identify significant differences in the Heart Rates over the time of the simulated competition (3 min, 30 sec), an analysis of variance for repeated measures was performed, considering three blocks of time (TB_i) lasting 1 min 10 sec each. Data were analyzed as percentage values (%) of HR_{max}. After performing the Mauclhy test of sphericity, the Greenhouse-Geisser ε, was used when appropriate. Effect Size (ES) in ANOVA was computed as ω^2, to assess meaningfulness of differences, with $\omega^2<0.01$, $0.01<\omega^2<0.06$, $0.06<\omega^2<0.14$ and $\omega^2>0.14$, as trivial, small, moderate, and large ES, respectively. The corresponding P values are provided for each analysis. The value of statistical significance was accepted with $P\leq0.05$. IBM-SPSS 20.0 for Windows

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was used to analyze and process the collected data.

Results

Physiological demands

Figure 1: reports the blood pressures (systolic and diastolic) recorded before and immediately after the end of the performance.

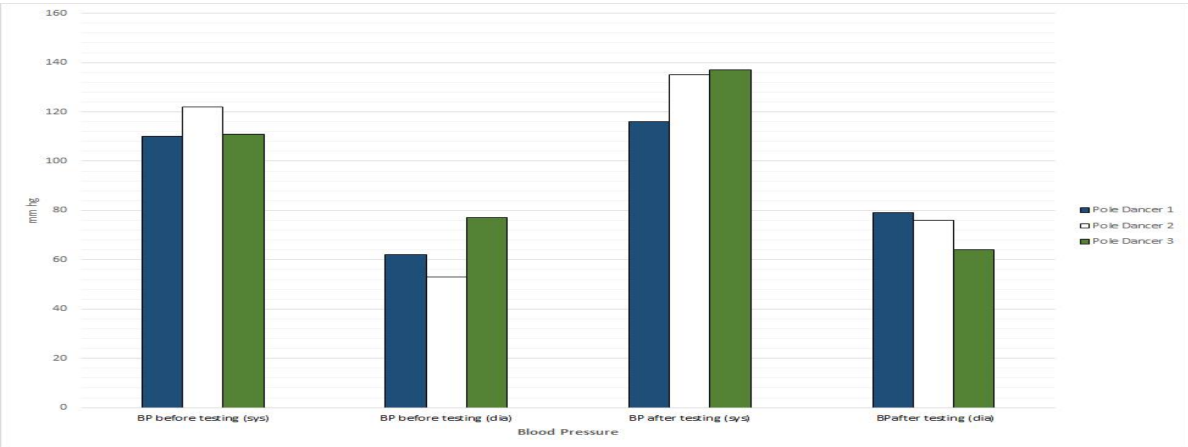

Figure 1: Values of blood pressure recorded during testing. (Sys=Sistolic; Dia=Diastolic).

In table 2 we reported the peak values and the mean values, as percentages of the pole dancers estimated maximal heart rates expressed as beats per minute (bpm).

Table 2: Heart Rates recorded during the simulated competition (SC) expressed as percentage of the estimated HRmax.

		SEM	Confidence Interval for the mean (95%)
Estimated HRmax (bpm)		—	—
Pole dancer 1 (f)	192		
Pole dancer 2 (f)	187		
Pole dancer 3 (m)	184		
$\%HR_{max}$ - Peak value		—	—
Pole dancer 1 (f)	121%		
Pole dancer 2 (f)	94%		
Pole dancer 3 (m)	128%		
Mean $\%HR_{max}$ (M±SD)			
Pole dancer 1 (f)	81.77±22.74%	0.50%	80.80-82.74%
Pole dancer 2 (f)	64.74±9.69%	0.21%	64.32-65.15%
Pole dancer 3 (m)	77.27±17.68%	0.39%	76.51-78.02%

M=mean; SD=standard deviation; SEM=standard error for the mean
$\%HR_{max}$= percentage of the maximal heart rate; bpm=beats or breaths per minute

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To study the changes in heart rates during the simulated competitions, we considered the sampled data assigning them in three different time blocks of 1 min 10 sec each: tb1, tb2, tb3 (see Figure 2 and Table 3).

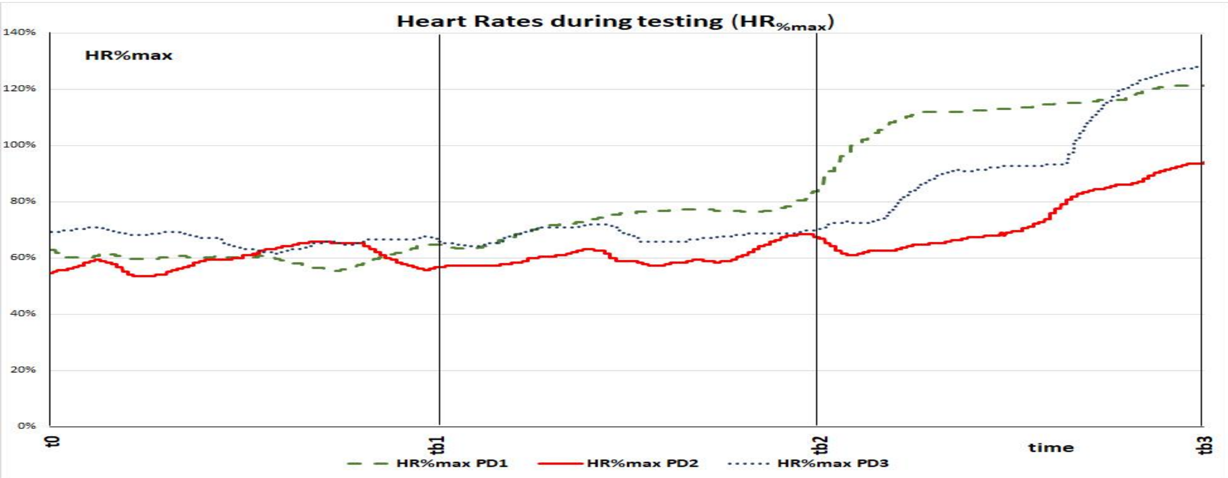

Figure 2: The Heart Rate expressed as percentage of the maximal HR (%), recorded during testing. Consider the three-time blocks during the performances.

Table 3: Heart Rates (HR; M±SD) recorded during the simulated competition (SC) lasting 3 min and 30 sec. We considered 3-time blocks (TB_i) of 1 min 10 sec each.			
	Pole Dancer 1 Heart Rate (%HRmax)	**Pole Dancer 2** Heart Rate (%HRmax)	**Pole Dancer 3** Heart Rate (%HRmax)
TB_1	59.92±3.01	59.58±3.89	66.72±2.45
TB_2	73.37±5.99	60.39±3.36	68.05±2.18
TB_3	111.89±8.78	74.12±10.89	96.83±18.40
Repeated measure ANOVA	$F_{2,1400}$=25238,20; P<0.0001 ω^2=0.97; power=1.0	$F_{2,1396}$=1372,11; P<0.0001 ω^2=0.66; power=1.0	$F_{2,1396}$=1708,14; P<0.0001 ω^2=0.70; power=1.0
TB_i=Time Block: 1 min 10 sec each $\%HR_{max}$= percentage of the maximal heart rate; bpm=beats or breaths per minute			

In table 4 we reported the blood lactate concentration values recorded during the simulated competition: after the warm up and immediately before the commencement of the simulated competition and at the end of the performance at 1,3,5 and 12 minutes respectively.

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Table 4: Blood Lactate concentration (Bla^-) recorded during SC (mmol/L)			
	Pole Dancer 1 Bla^- (mmol/L)	**Pole Dancer 2 Bla^- (mmol/L)**	**Pole Dancer 3 Bla^- (mmol/L)**
After the warm up	3.9	3.5	3.5
After the simulated competition: 1 min	12.3	9.0	13.0
After the simulated competition: 3 min	10.3	10.4	12.7
After the simulated competition: 5 min	8.9	10.8	12.2
After the simulated competition: 12 min	7.3	7.1	10.1
Bla^-=Blood Lactate Concentration SC=Simulated Competition.			

Physical Demands

In this analysis we decided to focus on the vertical vector (X vector in this device), since the main part of this performance is aimed at contrasting the gravitational force, both in terms of climbing the pole or controlling the falls or drops. The rotational values (°/s) of the center of mass of the performers around the pole were recorded by the means of the gyroscopes implemented in the Sensorize FreeSense ™ device.

In figures 3-5 we reported the values of acceleration recorded along the vertical axis X for all the participants together with the rotational values reached during these simulated competition.

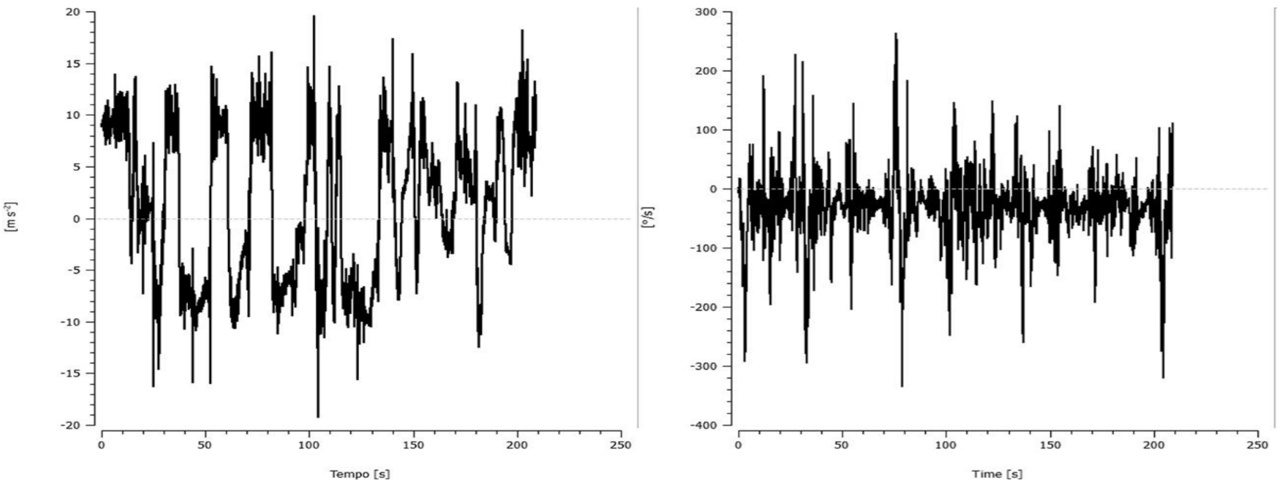

Figure 3: Pole Dancer 1: (FP, Female) Accelerations and rotational analyses using a tri-axial accelerometer device with gyroscopes (Sensorize FreeSense ™). Acceleration on the left side of the figure. The values recorded along the X-axis (vertical axis) are reported. Angular velocity (°/s) on the right side of the figure. The rotational values (clockwise and counter clockwise) recorded along the X-axis (vertical axis) are reported.

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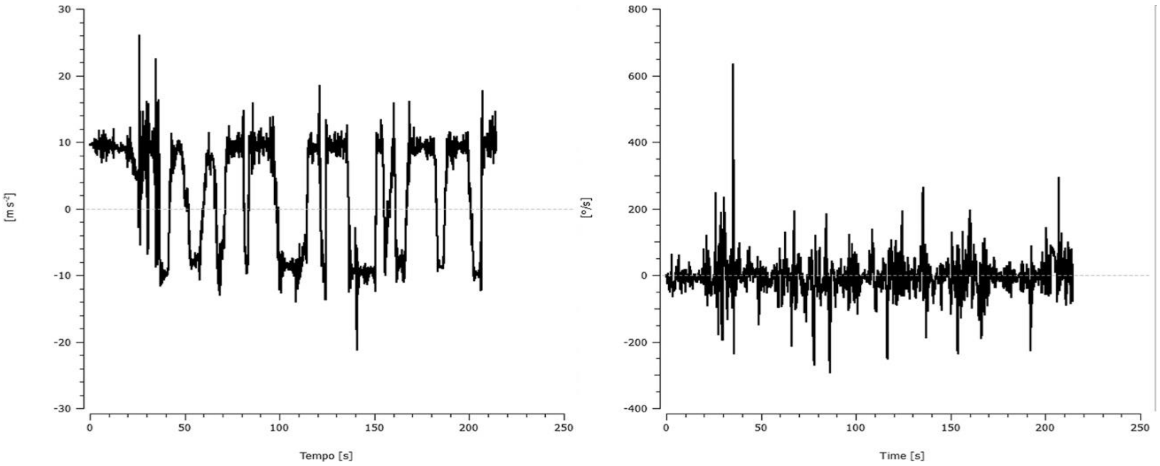

Figure 4: Pole Dancer 2: (TW, Female) Accelerations and rotational analyses using a tri-axial accelerometer device with gyroscopes (Sensorize FreeSense ™). Acceleration on the left side of the figure. The values recorded along the X-axis (vertical axis) are reported. Angular velocity (°/s) on the right side of the figure. The rotational values (clockwise and counter clockwise) recorded along the X-axis (vertical axis) are reported.

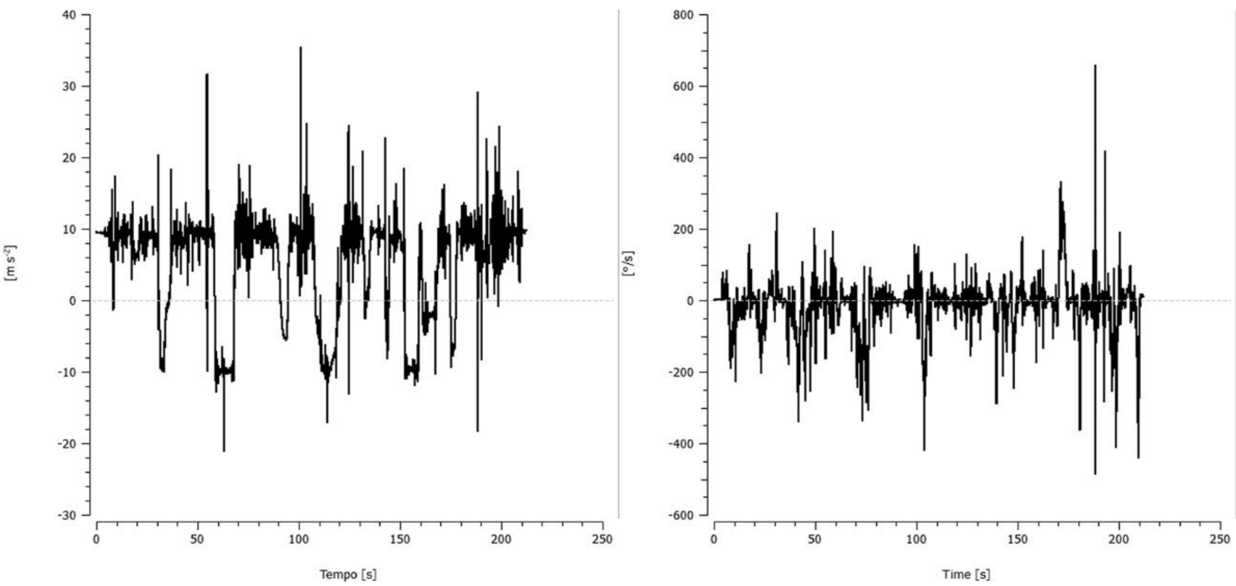

Figure 5: Pole Dancer 3: (MD, Male) Accelerations and rotational analyses using a tri-axial accelerometer device with gyroscopes (Sensorize FreeSense ™). Acceleration on the left side of the figure. The values recorded along the X-axis (vertical axis) are reported. Angular velocity (°/s) on the right side of the figure. The rotational values (clockwise and counter clockwise) recorded along the X-axis (vertical axis) are reported.

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Postural Stability

As indices of the postural stability of the participants, before and after the simulated competition, we collected data referring to the ellipse area of the projection of the COP on the ground (mm^2), the sway length (mm) and the mean velocity of the COP (mm/s), through the stabilometric platform. The relevant data for each participant are reported in table 5.

Table 5: Postural Stability recorded during testing

Testing	Pole Dancer 1			Pole Dancer 2			Pole Dancer 3		
	Surf. (mm^2)	**Sway (mm)**	**Vel (mm/s)**	**Surf. (mm^2)**	**Sway (mm)**	**Vel (mm/s)**	**Surf. (mm^2)**	**Sway (mm)**	**Vel (mm/s)**
Bipodalic, OE, Before	43.73	527.7	10.29	15.83	295.4	5.76	15.27	429.2	8.37
Bipodalic, OE, After	53.53	526.9	10.27	74.65	543.9	10.61	51.21	545.2	10.63
Monopodalic, L, EO, Before	78.79	139.8	27.63	46.15	72.8	14.38	280.45	99.5	19.69
Monopodalic, L, EC, Before	16339.96	970	191.7	779.05	176.9	34.97	1042.63	276.5	54.67
Monopodalic, R, EO, Before	142.85	95.5	18.87	55.05	83.4	16.48	160.04	103.1	20.37
Monopodalic, R, EC, Before	596.38	234.8	46.41	265.78	149.8	29.61	6239.71	436.5	86.26
Monopodalic, L, EO, After	103.3	80.6	15.92	81.31	110.4	21.81	221.55	191.9	37.91
Monopodalic, L, EC, After	1415.79	420.2	83.04	640.17	261.5	51.68	21933.12	1851.5	365.92
Monopodalic, R, EO, After	144.39	88.1	17.42	72.07	66	13.05	1014.99	180.6	35.7
Monopodalic, R, EC, After	821.78	230.7	45.58	568.38	146.5	28.91	43661.15	1455.8	287.81

L=left; R=right; EO= eyes open; EC= eyes closed; Surf=surface area (mm^2); Sway= Sway Lenght (mm); Vel=Mean Velocity of COP (mm/s)

Rating of Perceived Exertion (RPE)

We asked the pole dancers to indicate through the CR-10 Borg's scale the degree of perceived fatigue, respectively at the end of the warming up (mean score: 2.3±0.58 out 10) and at the end of this simulated competition (mean score: mean 8.5±0.50 out of 10).

Discussion

This is the first case study to our knowledge that describes the physiological, physical and postural demands of the Pole Dance, performed by top level athletes, practicing this discipline at the international level. The increasing relevance of this artistic physical activity, that is gaining worldwide attention and is expected to become, in the near future a real "sport status", has raised some research questions in our group of scholars. Currently there are no scientific papers available to provide a sufficient insight of this discipline, performed at the highest level, hence our decision to initiate this field of research, starting with this case report, to be considered as a pilot study for further researches, but nevertheless able to provide some useful information for those who want to better understand some of the physical and physiological aspects of this discipline.

We considered the cardiac commitment of these pole dancers during a simulated competition. The results we obtained highlighted a moderate to very intense physiological effort required to the dancers throughout the performance, although lower than we expected to find, especially in Pole Dancer 2, who was the highest in the world ranking among the participants. Being a simulated competition in a lab, we expected anyway to find physiological responses lower than in an actual performance given during a real competition.

As it is possible to see in figure 2 and in table 3, the intensity of these performances demands a mean heart rate (HR_{mean}) of about 74.6±16.7% of the maximal theoretical one, placing this discipline among other demanding ones, that show similar HR behaviors, as in women's and men's gymnastics [13,26].

The peaks of about 114.3±18.0 % of the HR_{max} ($HR_{peak\text{ - mean value}}$) reached especially at the end of the performances confirm the high-energy cost to be paid to perform at this level, at least in the final stages of the performances. In fact, to better understand the distribution of the effort throughout the duration of the performances that we have analyzed, we have divided the tests, which lasted for three minutes and thirty seconds, in three-time blocks of equal duration - i.e. $TB_{i=}$ one minute and ten seconds each - (see Table 3). The changes in heart rate are statistically significant in all the participants (repeated measures ANOVA, P<0.001). Subsequent post-hoc tests, performed with Bonferroni correction of significance level, showed statistically significant differences between the values recorded over time (tb1 vs tb_2, P<0.001; tb1 vs tb3, P<0.001; tb2 vs tb3, P<0.001).

This analysis allowed us to define some temporal patterns [23] of the heart rates that may have some significance in designing training sessions specific to this discipline, at this level. In particular, we highlight the fast heart rate reached in the third time block (about 94% HR_{max}), where actually the postures of greater qualitative merit have concentrated (see Table 3 and Figure 2). The blood lactate concentration data confirm the glycolytic nature of the pole dance (ranging from 11.43 to 8.16 mmol/L, from 1' to 12' after the end of performance). In particular, we emphasize that the blood lactate concentrations we found are greater than the average blood lactate concentration found during different women's sports performances, such as in women's gymnastics, in sport dance, etc. [3,4,21,22,27]. Since the pole dance performances show a certain degree of the total workload based on the ability to perform some strong isometric contractions, and knowing the possible implications that this kind of exercise might have on the blood pressure, we reported the values of the BP taken before and after the completion of this simulated competition (Figure 1).

Under the physical standpoint, the accelerations (positive and negative) found on the vertical axis emphasized the constant physical work needed, aimed at contrasting the effect of the gravitational force. What seems to be particularly interesting is the amount of work aimed at breaking the body along the pole during those controlled phases of falling or dropping down (Figures 3-5). This aspect introduces the issue of the strategy needed to cope with the pain [24,25] and its influence on the performance. As already stated, the pole dancer uses his/her hands and other surfaces of the body (mainly the legs and the thighs, the arms, the abdomen, etc.) as "brakes", thus relying on the friction forces between his/her skin and the pole, to control these falls. The number of peak accelerations counted during this experimental phase emphasized the amount of work in which all these braking phases are sustained by this mechanism. The rotational aspects of this performance (Figures 3-5) showed the need of particular adaptations of the vestibular organs [26] in order to allow the pole dancer to efficiently control and keep the postures that are required to reach the higher quality of motor expressivity, although the body is engaged in rotating movements around the pole of a certain magnitude -≈400°/s).

The kinematics of this activity, based on vertical accelerations (positive and negative) along the pole, should be considered mainly in its anti-gravitational component: the pole dancer should master the skill of climbing on the pole and, more demanding, to contrast the effect of gravity, especially when the dancer has to cope with some specific technique, based on controlled drops or dives along the pole (with a braking phase requiring about 3 G). The rates of force needed to perform at this level are high, requiring a particular strength in the hand grip [13]. Another aspect that raised additional questions is the ability of the dancers to cope with the pain caused by the friction forces acting on the several surfaces of the body in contact with the pole. The training protocols indeed find their limits in this ability to control the pain and many dancers claimed this aspect to be the worst part of their activity [24,25,28]. From the postural point of view, we can say that the postural changes observed in the athletes after testing, witness the disturbing effects on the balance induced by this specific exercising. It is also noted in all three athletes a search for balance strategy strongly focused on the optical analyzers - i.e. the sight skills -, which seems to be crucial especially in the mono-podalic search for balance.

Research Limitations

The most obvious limitation of this study is the number of subjects who participated (N=3). So, all the evidences shown in our research should be treated with extreme caution and can only be used as initial reference for possible comparisons with athletes of the same gender, age and specific sporting experience. Lack of generalizability is a common trait in qualitative studies, conducted on small samples or even consist of a single individual. However, we want to emphasize the importance of such a research when the total lack of published studies does not allow any speculation based on scientific evidence. Of course, we do hope that this first study will stimulate other researches, with adequate sample sizes, able to define the correct performance models in this discipline, with particular reference to the gender and the level of qualification (i.e. elites vs. sub elites).

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Conclusions

In our study, we were able to design a first performance model of pole dance, investigated at the elite level, under a physiological and physical standpoint. The evidences we found - i.e. the cardiac commitment, the concentration of blood lactate, the amount of antigravitational work - might be considered as clear indications of a discipline that needs a careful and skilled training methodology, specific coaching knowledge and led us to define the pole dance as a demanding physical activity, that might pose heavy requirements on those practicing this discipline. The use of the information we provided with this paper might help the pole dance coaches and the strength and conditioning trainers in their work, since we were able to provide a first insight into the discipline, based on some measurements of the most common physical and physiological parameters, that sport scientists and coaches usually take into account in their professional activities. We still want to emphasize the importance of a performance model, although resulting from a small sample study, which might be able to properly and safely orientate the decisions of the coaches involved in the design and in the management of training sessions aimed at improving the technical and the physical sides in this sport discipline.

Author Contributions

Conceptualization, Bruno Ruscello, Mario Esposito and Stefano D'Ottavio; Data curation, Bruno Ruscello; Formal analysis, Bruno Ruscello; Investigation, Bruno Ruscello, Mario Esposito, Laura Pantanella, Filippo Partipilo and Laura Lunetta; Methodology, Bruno Ruscello, Mario Esposito and Laura Pantanella; Project administration, Bruno Ruscello and Mario Esposito; Software, Bruno Ruscello, Mario Esposito and Filippo Partipilo; Supervision, Bruno Ruscello and Stefano D'Ottavio; Validation, Bruno Ruscello, Mario Esposito, Laura Pantanella and Laura Lunetta; Visualization, Bruno Ruscello and Mario Esposito; Writing - original draft, Bruno Ruscello; Writing-review & editing, Bruno Ruscello.

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