



EDITORIAL

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Is it safe to dance flamenco during pregnancy? Biomechanical considerations

¿Es seguro bailar flamenco durante el embarazo? Consideraciones biomecánicas

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Abstract

Flamenco has become nowadays a very popular dance style over the world. The percussive footwork and vibration patterns created during dancing imposes high demands on the musculoskeletal system and the forces transmitted from the foot in a proximal direction could contribute to the stress urinary incontinence. Therefore it may be questionable for the women during pregnancy. That is why the purpose of this study was to investigate the level and effects of dynamic loading on the musculoskeletal system of the flamenco dancer during advanced pregnancy. The participant of the study was a female in the third trimester of pregnancy (34.5 yrs, 76 kg, 1.72 m). She has been practicing flamenco for 15 years. The task of the subject was the execution of ZAP-3 Test: a sequence of six footworks performed with the forefoot, heel and toes, alternatively with both feet during 15 seconds at maximum speed. Kinetic data were collected with a Kistler force plate. Afterwards, the subject filled the Waterloo Footedness Questionnaire-Revised and questionnaire on health condition. As the registrations revealed, strikes with different parts of the foot generate different impacts to those elements. The average values of the vertical component of GRF normalized to body weight throughout the whole test ranged between 0.49 («Punta») and 3.22 BW («Tacán de Planta»). On the basis of questionnaire and interview, the pregnant subject reported neither urogenital disorders, nor musculoskeletal injuries. At the same time, gravida emphasized being familiar with the pelvic floor muscles training. Due to visual observation, a proper alignment of the dancer's body was identified: vertical trunk, stabilized spine, optimal stable pelvic position. Additionally our expectant mother performed proper configuration of the lower limb joints with semi-flexed knees and hips. To conclude, flamenco dancers should be supported to continue their training during pregnancy but the amount of loadings during classes should be discussed (type, Intensity, duration frequency of exercises). Any symptoms of pain or discomfort warrant examination by a physician. Then, as flamenco works on the core of the body, it can also help with pelvic floor muscles, assuming that the subject is aware of the right body alignment and muscle activity. That is why the attention should be more focused on the education of the dancers' body awareness in ergonomic technique.

Keywords

Flamenco dancing, overloadings, footwork, posture.

Resumen

El flamenco se ha convertido en la actualidad en un estilo de baile muy popular en todo el mundo. El zapateado y los patrones de vibración generados durante el baile imponen altas exigencias al sistema musculoesquelético, esto unido a las fuerzas transmitidas desde el pie en dirección proximal podrían contribuir a una incontinencia urinaria por esfuerzo. Por lo tanto, puede ser cuestionable para las mujeres durante el embarazo. Es por ello que el propósito de este estudio fue investigar el nivel y los efectos de la carga dinámica sobre el sistema musculoesquelético de una bailaora durante su embarazo avanzado. La participante del estudio era una mujer en el tercer trimestre del embarazo (34,5 años, 76 kg, 1,72 m). Practica baile flamenco desde hace 15 años. La tarea que realizó la participante fue la ejecución del Test ZAP-3: una secuencia de seis juegos de pies realizados con el antepié, el talón y la puntera, alternativamente con ambos pies durante 15 segundos a máxima velocidad. Los datos cinéticos se recogieron con una placa de fuerza Kistler. Posteriormente, el sujeto completó el Waterloo Footedness Questionnaire-Revised y un cuestionario sobre el estado de salud. Según revelaron los registros, los golpes con distintas partes del pie generan impactos diferentes a esos elementos. Los valores medios de la componente vertical de la GRF normalizada al peso corporal a lo largo de todo el ensayo oscilaron entre 0,49 («Punta») y 3,22 BW («Tacán de Planta»). Sobre la base del cuestionario y la entrevista, la embarazada no informó trastornos urogenitales ni lesiones musculoesqueléticas. Al mismo tiempo, la embarazada manifestó estar familiarizada con el entrenamiento de los músculos del piso pélvico. Por observación visual se identificó una correcta alineación del cuerpo de la bailarina: tronco vertical, columna estabilizada, posición pélvica estable óptima. Adicionalmente la futura madre realizó una correcta configuración de las articulaciones de los miembros inferiores con rodillas y caderas semiflexionadas. Para concluir, se debe apoyar a las bailaoras de flamenco para que continúen su entrenamiento durante el embarazo, pero se debe discutir la cantidad de cargas durante las clases (tipo, intensidad, duración, frecuencia de los ejercicios). Cualquier síntoma de dolor o incomodidad justifica el examen por un médico. Como el flamenco trabaja la parte central del cuerpo, puede ayudar también con los músculos del suelo pélvico, suponiendo que el sujeto sea consciente de la correcta alineación del cuerpo y la actividad muscular. Es por eso que la atención debe estar más enfocada en la educación de la conciencia corporal de los bailarines en la técnica ergonómica.

Palabras Clave

Baile flamenco, sobrecarga, zapateado, postura.

Introducción

Flamenco has become nowadays a very popular dance style all over the world. On one side it is a highly emotional and sensual dance, on the other side it is highly demanding in terms of technique involving the whole body [1]. The characteristics of this dance include: the use of steps on shod feet and shoe strikes (*zapateado*), and typical steps including a high variety of arms-wrists-hands and fingers movements [2]. Considering complex nature of flamenco movements and gestures, the focus of the recent investigations is placed on the loading of the body during footwork *zapateado* performed in traditional high-heeled shoes [3-5]. It may stem from the fact that the percussive footwork and vibration patterns created during dancing imposes high demands on the musculoskeletal system [6]. Additionally, the forces transmitted from the foot in a proximal direction could contribute to the stress urinary incontinence [7] defined as the "involuntary loss of urine on effort or physical exertion, or on sneezing or coughing". The urogenital disorders are the most frequent conditions after musculoskeletal pathologies, chronically affecting 50% of the group of dancers [7], which was observed also by Bejjani et al. [8] in flamenco dancers. Pregnancy is among the potential predisposing risk factors in leakage in women. Therefore practicing flamenco dance may be questionable for women who become pregnant during their dancing career.

Pregnancy causes several changes in a future mother in order to adapt her body to constantly increasing needs of the fetus [9]. Anatomical alterations and adaptation of metabolic processes impose a functional adaptation of the musculoskeletal system [10, 11]. Changes that accompany pregnancy are most clearly manifested in a body mass growth, pelvic tilt increase counterbalanced by an increased lordosis in the lumbar region [12, 13]. The adaptations can effectively, from a biomechanical point of view, control the position of the mother's center of mass (CoM), both in relation to the main joint of lower limbs and the base of support [13]. It is of a significant importance in maintaining stable posture and limiting risks of falls during gestation.

Unfortunately for the dancer, many healthcare providers discourage dance during pregnancy, despite the evidence that exercise enhances positive outcomes for both the mother and

baby [14]. The benefits of being physically active during pregnancy include: improved maternal psychological well-being, reduced risk of pre-eclampsia, gestational hypertension, gestational diabetes, excessive gestational weight gain, delivery complications and postpartum depression and no increase in risk of stillbirth, newborn complications or adverse effects on birth weight [15-17]. Therefore, in the national and international guidelines one can find specific recommendations [18, 19] encouraging pregnant women to perform aerobic and strengthening exercises of moderate intensity for at least 150 min per week in the absence of any medical or obstetric complications.

However, bearing in mind that not all sports have the same impact on pregnancy, intensity and duration of exercise sessions should be taken into account [15]. Also if we consider the level of proficiency in dance.

Although much is known about low to moderate physical activity during pregnancy, data on elite and competitive amateur female athletes remain limited [20, 21]. The physical effort demanded in performing flamenco is similar to that of elite sports [1, 22]. Due to ethical reasons, there is a lack of studies that evaluate maximal intensity exercise exposure during pregnancy. However, there are no known significant negative consequences of physical activity for mothers or children.

That is why the purpose of this study was to investigate the level and effects of dynamic loading on the musculoskeletal system of the flamenco dancer during advanced pregnancy. The intention of the author is to open the discussion on this issue encouraging the scientists, teachers or flamenco dancers to share their opinion and experiences.

Material and methods

The participant of the study was a female flamenco dancer in the third trimester of pregnancy (table 1). She has been practicing flamenco for 15 years. The subject executed ZAP-3 Test: a sequence of six footworks performed with the forefoot, heel and toes, alternatively with both feet. She repeated the sequence of steps in high-heeled shoes (6 cm) for 15 seconds at maximum speed according to protocol by Vargas [1]. The test ZAP-3 was performed twice, in order to pla-

ce both the right and left feet on the force platform. The footwork test was carried out in the Biomechanics Laboratory at the University of Physical Education in Krakow, Poland. Kinetic data (the vertical component of ground reaction force [GRF]) were collected with a Kistler force plate (1000 Hz sampling rate). Afterwards, the subject was asked to fill the Waterloo Footedness Questionnaire-Revised [23] and questionnaire concerning her health condition. The questionnaire was composed of simple questions designed to obtain information about the characteristics of the dance training, any previous injuries or diseases, and to find out about the presence of any stress urinary incontinence.

The kinetic data derived from the case study by Vargas-Macias et al. [4] and Forczek-Karkosz et al. [5] were used as a reference data (control subject).

The research was conducted according to the ethics principles stated in the Helsinki Declaration. The flamenco dancer gave informed consent to participate in the research.

Analysed data

To accomplish the purpose of this work, there were chosen for the analysis the maximal values of vertical component of the ground reaction force (GRF) and GRF normalized to body weight (BW) for two out of 6 footwork steps:

- **Tacón de Planta** – the second strike provided by the dropping the heel on the floor;
- **Punta** – the sixth strike provided by tapping the tip of the toe on the floor.

Additionally, on the basis of a qualitative analysis, it was observed the alignment of the whole body during the ZAP-3 performance.

Results

The characteristics of the dancers' body (pregnant and control subject) is presented in table 1.

During the measurement sessions, the dancer achieved a mean frequency of footwork 9.0

Table 1. The anthropometric data of the subjects

	Pregnant Subject	Control [4, 5]
Age [yrs]	34.5	34
Body mass [kg]	76	58
Body height [m]	1.72	1.65
BMI [kg/m ²]	25.67	21.30
Gestation [week]	35	-

steps/s (135 footwork steps in each performance). As the registrations revealed, strikes with different parts of the foot generate different impacts to those elements. The average value of the vertical component of GRF normalized to body weight throughout the whole test ranged between 0.49 and 3.22 BW (see Table 2).

The most dynamic strike was provided by the dropping heel on the floor (Tacón de Planta). While for the pregnant subject the mean value of GRF was more than three times higher than her body weight (BW), the forces registered for the control subject were twice the of her

body weight. The left leg occurred to be dominant for the gravida, which was confirmed by the Waterloo Footedness Questionnaire-Revised. The force provided by tapping the tip of the toe on the floor (Punta) was of the lowest value (~0.5 BW), similar for both subjects.

On the basis of questionnaire and interview, the pregnant subject reported neither urogenital disorders, nor musculoskeletal injuries. At the same time, gravida emphasized being familiar with the pelvic floor muscles training.

Due to visual observation, a proper alignment of the dancer's body was identified: vertical

trunk, stabilized spine, optimal stable pelvic position. Additionally our expectant mother

performed proper configuration of the lower limb joints with semi-flexed knees and hips.

Table 2. Maximal value of the vertical component of ground reaction force (GRF max) and ground reaction force normalized to body weight (GRF/BW) for two characteristic footwork of the ZAP-3 test (R – right leg, L – left leg, PS – pregnant subject, CS – control subject)

Footwork Step	Variable	R-PS	R-CS	L-PS	L-CS
Tacón de Planta	GRF max [N]	2215 ± 289	1541 ± 130	2406 ± 335	1537 ± 198
Tacón de Planta	GRF/BW	2.97 ± 0.4	2.15 ± 0.18	3.22 ± 0.45	2.15 ± 0.28
Punta	GRF max [N]	365 ± 79	334 ± 128	388 ± 94	374 ± 110
Punta	GRF/BW	0.49 ± 0.1	0.47 ± 0.18	0.52 ± 0.12	0.52 ± 0.15

Discussion

Current research recommends physical activity during pregnancy for women who were habitually engaged in vigorous-intensity aerobic activity or who were physically active before pregnancy [18, 19]. Furthermore, according to the latest study, there are no known significant negative consequences of physical activity for mothers or children taken by sportswomen. Dance is one form of exercises recommended during pregnancy [24] which is an excellent way to improve physical fitness and mental health [25]. Considering a unique characteristics of the flamenco footwork technique requiring a lot of effort from the dancers striking the floor to make a loud and rhythmic sound [4, 26], the physical condition of flamenco dancer is similar to those of elite sports [22]. As the study emphasized sportswomen should be supported to continue their training, with adjustments to intensity and type of activity where appropriate, in addition to adequate supervision and monitoring from healthcare professionals [20, 21], one can suggest flamenco dancers should be supported to continue their training but the amount of loadings during classes in gestation period should be discussed (type, Intensity, duration frequency of exercises). Any symptoms of pain or discomfort warrant examination by a physician.

Generally it is important to maintain biomechanical integrity of the body in any kind of

movements. Especially the body of a gravid woman is changing and more vulnerable to the strains and discomforts as a consequence of applying physical effort in inefficient ways. Weight gain in combination with ligamentous laxity may increase joint discomfort and, consequently, affect the daily activities, e.g. gravidas are reported to be at high risk of falling [27]. Therefore they enhance a more tentative walking pattern with a reduced velocity, cadence and a wider step [12, 28]. Foti et al. [12] called for the need of physical training during pregnancy and postpartum period, emphasizing “appropriate exercise and conditioning programs during pregnancy in order to avoid overuse injury to specific muscle groups.” Regular exercises during pregnancy are associated with an increased muscle strength and thus may reduce fall risks and enhance subject’s stability [29]. Dancing in pregnancy can favor maintaining a proper body posture and keeping the muscles in good condition as it involves the whole body. Due to the proper position of the body of our pregnant subject, the dynamic, smooth and rhythmic performance of footwork was safe for the dancer in terms of body stability also confirmed by the subject during daily activities. The questionnaire revealed lack of complaints about any discomfort or strains during daily movements.

One can ask: what about high frequency waves going up from the foot up to the spine while performing zapateado? Taking into account the study by Bejjani et al. [8] who assu-

med that high prevalence of urogenital disorders in flamenco dancers has been attributed to the vibration suffered by the whole body. Stress urinary incontinence occurred in 22.2% cases during the classes of flamenco or traditional Spanish dancing, such as tap dancing [7]. Continence in women depends on their anatomical, hormonal, cellular, and neurological status, but also on the stress to which the pelvic floor is exposed [7, 8]. Pelvic floor muscles have two important roles; they serve as the support for abdominal organs and are crucial for closure of the urethra, vagina and rectum. Their condition may be affected by e.g. the shock waves initiated with foot – ground contact associated with any type of motion, such as: walking, running, dancing. Some of the activities may enhance stress urinary incontinence. Therefore the musculoskeletal system has to attenuate and dissipate the forces acting on the body during movement. Proper configuration of the lower limb joints is one of the natural mechanisms of shock cushion during zapateado. The results of this study revealed the most dynamic strike three times higher than the subject's body weight. It is similar to running impacts. The inability of the legs and feet to dissipate the force could affect the magnitude of the impact on the pelvic floor, which would have to be absorbed there instead [30]. Although our pregnant subject did not have any urogenital disorders, she underlined her awareness about pelvic floor muscles training. So this seems to be a crucial practical implication for the female dancers. They should be instructed by the specialist – even before pregnancy- how to contract the pelvic floor muscles. Then, as flamenco works on the core of the body, it can also help with pelvic floor muscles, assuming that the subject is aware of the right body alignment and muscle activity. That is why the attention should be more focused on the education of the dancers' body awareness in ergonomic technique. During gestation this knowledge should be incorporated with special attention. Training of the pelvic floor is effective at treating stress urinary incontinence [31]. Keeping these muscles in a good condition before pregnancy may help to cope with some disturbances when this area of the body is overloaded as a result of a growing fetus.

Conclusions

In the course of pregnancy women should have a wide range of preventive strategies to reduce the risk of overloading generated during the footwork. Among the most important are:

- keeping the body properly (semi-flexed knees and hips, stable pelvis);
- using the sport shoes throughout pregnancy, especially during training sessions, dancing on a sprung wood surface;
- careful consideration should be given to the load during the dance class (type, intensity, duration and frequency of exercises);
- the programme of training content in pregnancy should be adjusted individually;
- caution must be recommended for mothers with pre-existing medical conditions or complications developing during pregnancy.

Among other recommendations are those suggested by ACOG [18]:

- prolonged exercise should be performed in a thermoneutral environment or in controlled environmental conditions (facilities with air conditioning) and pregnant women should avoid prolonged exposure to heat and pay close attention to proper hydration and caloric intake. Maintaining proper hydration and sustaining adequate caloric intake to prevent weight loss, which may adversely affect fetal growth;
- competitive athletes require frequent and close supervision because they tend to maintain a more strenuous training schedule throughout pregnancy and resume high-intensity training postpartum sooner than other women;
- pregnant women should be informed by their healthcare provider of the danger signs for when to stop, or limit physical activity and to consult a qualified healthcare provider immediately if they occur. However, in many cases, the guidance related to training during pregnancy is not satisfying [32]. Although, cooperation with specialists could be challenging, it should become a natural practice for women throughout her pregnancy period.

Other considerations

To the knowledge of the author, the subject stop practicing flamenco at 38 week of pregnancy and she gave birth in 41 week of gestation by uncomplicated vaginal delivery (female: 3820 kg, Apgar scale 10).

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