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Epidemiology of athletic injuries in classic ballet practitioners

Epidemiologia de lesões musculoesqueléticas em praticantes de ballet clássico

Epidemiologia de lesiones musculoesqueleticas en practicantes de balé clásico

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ABSTRACT | Specific overloads of ballet practice may represent risk factors for injuries. The objective of this study was to analyze the epidemiology of typical injuries of ballet, including factors associated with history of injury in ballet practitioners. Studied subjects integrated 124 dancers, of both genders, from nine ballet schools from Campo Grande, Mato Grosso do Sul State, Brazil. To obtain information about injuries, we used a morbidity survey. Participants were divided into two groups: G1 (with injuries) and G2 (without injuries). In relation to prevalence of injuries, 89 cases were registered, and 61 dancers (49%) reported damages incidence, with record of 1.48 cases per practitioner. Moreover, the G2 presented higher body weight (G1: 51±8 *versus* G2: 55±10 kg) and training time (G1: 4.0±2.0 *versus* G2: 5.0±4.1 years). With respect to injury type, joints (32%) and muscle affections (25%) were the main occurrences in the lower limbs (85%) due to specific exercises (30%). Weekly exposure time was the most important mechanism to injury installation. The more important causal circumstance to injury occurrence was constituted by specific training (49%) and choreographic performance (41%). In conclusion, evidences have showed that joint injuries in lower limbs are the main classical ballet injuries in ballet practitioners, and weekly exposure time is the most important factor associated with injuries in classical ballet.

Keywords | Dancing/injuries; Exposure Time; Descriptive Epidemiology.

RESUMO | Demandas específicas da prática de *ballet* podem representar fatores de risco para lesões musculoesqueléticas. Este estudo teve por objetivo analisar a epidemiologia das lesões típicas do *ballet*, com fatores associados ao histórico de lesão em bailarinos. A casuística integrou 124 participantes de ambos os sexos, procedentes de nove escolas e companhias de *ballet* de Campo Grande, no Mato Grosso do Sul. Para registro de lesões, utilizou-se um inquérito de morbidade referida. Os participantes foram distribuídos em dois grupos: G1, sem lesão, e G2, com lesão. Em relação à presença de lesão, foram registrados 89 casos, sendo que 61 bailarinos (49%) relataram terem se lesionado, com registro de 1,48 casos por praticante. O G2 apresentou maior massa corporal (G1: 51±8 *versus* G2: 55±10 kg) e tempo de treinamento (G1: 4,0±2,0 *versus* G2: 5,0±4,1 anos). Houve predomínio de lesões articulares (32%) e musculares (25%) nos membros inferiores (85%), decorrentes de exercícios específicos (30%). O maior tempo semanal de prática configurou o principal fator de risco para lesão. A circunstância que mais provocou lesões foi o treino específico (49%), seguido pelo ensaio de coreografia (41%). Conclui-se que as lesões articulares em membros inferiores são as principais lesões do *ballet* clássico, e o tempo semanal de exposição constitui o principal fator associado a lesões no *ballet* clássico.

Descritores | Dança/lesões; Tempo de Exposição; Epidemiologia Descritiva.

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RESUMEN | Demandas específicas de la práctica de balé pueden representar factores de riesgo para lesiones musculoesqueleticas. Eso estudio tuvo como objetivo analizar la epidemiologia de lesiones típicas del balé, con factores asociados a la historia de lesión en bailarines. Hubo la integración de 124 participantes de los dos géneros, procedentes de nueve escuelas de balé de Campo Grande, Mato Grosso do Sul, Brasil. Se utilizó una averiguación de morbidad referida para registrar las lesiones. Los participantes fueron distribuidos en dos grupos: G1, sin lesión, y G2, con lesión. Con relación a la presencia de lesión, se registraron 89 casos, y 61 bailarines (un 49%) reportaron lesiones con registro de 1,48 casos por practicante. El G2 presentó mayor masa corporal (G1: 51±8 *versus* G2: 55±10 kg) y tiempo de entrenamiento (G1: 4,0±2,0 *versus* G2: 5,0±4,1 años). Hubo predominancia de lesiones articulares (32%) y musculares (25%) en las extremidades inferiores (85%) originarias de ejercicios específicos (30%). El mayor tiempo semanal de práctica se configuró como el principal factor de riesgo para lesión. La circunstancia que más causó lesiones fue el entrenamiento específico (49%), seguido por el ensayo de coreografía (41%). Se concluso que las lesiones articulares en extremidades inferiores son las principales lesiones del balé clásico, y el tiempo semanal de exposición se constituye el principal factor asociado a las lesiones en el balé clásico.

Palabras clave | Baile/lesiones; Tiempo de Exposición; Epidemiologia Descriptiva.

INTRODUCTION

Dancing has always been present in the history of mankind and it has been used as a cultural element, instrument of seduction or even of power. It was an integral part of sacred rituals, civic and seasonal celebrations[1]. The classical *ballet* was born with the Renaissance in the sixteenth century, in the court of the Medici, in Paris, France, initially reflecting gestures, movements and cultural patterns of the time[2]. Its practice was restricted to the nobility and it was strongly incorporated into the curriculum of the formal education of adolescents and young adults[2,3].

In the physical aspect, practicing dancing requires continuity, specificity, individuality, precision, psychomotor coordination, flexibility, laterality, spatial concept, physical fitness condition and body language[4,5]. In this sense, the classical *ballet* is an activity which implies important different physical and motor applications, integrating movement and position requirements which are considered as being anti-anatomic and reflecting, most often, in articular and postural overload[2,3,5]. In general, *ballet* demands result from warm-up, stretching and flexibility exercises, from the falls, the jumps, the balance, the extreme range of movement, the dynamic forces, the aerobic and anaerobic resistance, among others, in the search for the best timing and an accurate technical performance[4,6].

In the sports aspect, these specific demands from dancing may represent extrinsic factors related to the onset of injuries in dancers. Other extrinsic factors include the kind of floor, the room temperature and the shape of the ballet shoes. It is noteworthy that the continuous use of pointe ballet shoes is a potential risk factor in the development of injuries and losses in performance[7]. The intrinsic ones, on the other hand, consist of anatomical and biomechanical abnormalities, such as muscle shortening, hypermobility and muscles weakness, anthropometric characteristics, flexibility and history of injuries[8-10]. The onset of injuries is common to any sports modality and, the higher the number of risk factors, whether intrinsic or extrinsic, the more likely is the occurrence of orthopaedic and traumatic injuries[11,12].

In the epidemiological context, the main medical conditions of classical *ballet* dancers include dermal abrasions and blisters, articular disorders, fractures and lumbar disorders[13]. Nonetheless, the evidences on the epidemiology of injuries among *ballet* dancers are not yet sufficient, considering possible factors associated to their history, in different performance categories. Therefore, the present work aims at analyzing the epidemiology of typical classical *ballet* injuries, related to potential factors associated to the history of injuries among *ballet* dancers. It is considered, as an initial hypothesis, that the kind of shoes is related to the onset of injuries among *ballet* dancers.

METHODOLOGY

Participants

A analytical observational descriptive research, cross-sectional, including 124 practitioners of classical *ballet*, from nine schools and *ballet* companies from Campo Grande, in Mato Grosso do Sul. The volunteers were of both genders and were 17.6±5.2 years old; 53.1±9.2 kg of body mass; 162.5±7.9 cm of height and 8.5±4.9 years of history as a *ballet* practitioner. As an inclusion criteria, it was established a minimal frequency of two classes per week, each lasting one and a half hour or more. The participants

and/or their guardians were informed on the objectives of the research, as well as on the volunteer nature of their participation and signed an Informed Consent Form. This research was approved by the Research and Ethics Committee of the *Federal University do Mato Grosso do Sul* (UFMS), approval No. 230.163/2013.

The volunteers were distributed into two groups, defined according to the occurrence of injuries. Group 1 (G1) consisted of practitioners without previous injuries at the moment of the interview, while Group 2 (G2) consisted of participants who reported, at least, one injury within the 24 preceding months.

Collection of anthropometric and nosographic information

The height was measured with the use of a metric tape attached to the wall, and the body mass was obtained with the use of a digital scale. For the collection of information on injuries occurred within the last two years, we used the Morbidity Survey (MS)[14]. The changes performed in order to adequate the MS to the reality of the modality at matter involved the specific motor gestures of *ballet*[15]. Thus, the mechanisms were classified into: jump, spin/spin, stretching, strength, use of the pointe, repetitive movement, fall/shock/collision or inadequate posture. Besides that, the period when the injury occurred was separated into three classes: bar training, specific gesture training or choreography rehearsal. The requirement for medical-therapeutical treatment was considered in case the injury would be diagnosed and/or treated by a health professional. The symptoms of the athlete's return to the activity were registered after each reported injury was approached.

For study purposes, the injury was defined as any symptomatic manifestation of pain or physical dysfunction, due to training practice or dance competitions resulting in training alterations, whether in form, duration, intensity or frequency[16]. The whole process for the acquisition of information was performed by two trained researchers and began with the approach to the participant and/or guardian, with explanations on the objectives and development of the study, instructions to fill-out the Informed Consent and notes on the survey itself.

Statistical Analysis

The demographic and anthropometric results, as well as the training history, are presented in descriptive measures and were analyzed by the use of a Student's *t*-test for the independent samples. The epidemiological quantitative concluded data were expressed by absolute and relative distribution (%) and analyzed with the Goodman test[17]. All conclusions were discussed for 5% of statistical significance. Having met this, the relative risk (*Odds Ratio*) was calculated, through the association analysis between the variables of the study.

RESULTS

In Table 1, the demographic measures, the practice history and the incidence of injuries are presented. The G2 presented higher body mass and weekly exposure time; among the 124 assessed dancers, 61 (49%) of them reported having gotten injured, totaling 1.48 cases per practitioner (Table 1). Besides, 16 participants (26%) reported injury recurrence.

No statistically significant association was observed between age or the use of the pointe and the occurrence of injuries, though the number of pointe users was higher in both groups. In relation to the weekly training time, the G2 had most participants who trained for four or more hours a week; in the G1, where there was a balance between practitioner of up to four hours or more (Table 2). In particular, equal or more than four hours of exposition time was associated to a 2.1 higher chance of injury incidence (OR=2.09; 95%CI 1.00–4.36; p=0.049).

Furthermore, it was observed a predominance of articular (44%) and muscle (34%) disorders of the lower limbs. There were no injuries in the head and neck segments found in the dancers (Table 3).

Regarding injury distribution, according to the nature and mechanism of the manifestation, it was observed that the predominance of muscle (65%) and tendon (22%) impairments are due to stretching. Approximately half

Table 1. Demographic and anthropometric practice profiles, according to the occurrence of athletic injuries

Variables	Group		p-value
	G1 (n=63) Mean±SD	G2 (n=61) Mean±SD	
Age (years)	17.3±5.2	18±5.3	0.377
Height (cm)	161±7.6	163±7.8	0.055
BW (kg)	51±8.0	55±9.7*	0.025
TH (years)	7.7±4.1	9.2±5.5	0.221
WTT (hours)	4.0±2.0	5.0±4.1*	0.027
Subjects (n)	63	61	-

G1: group of practitionars without history of injury; G2: group of practitioners with injury; SD: standard deviation; TH: training history; WTT: weekly time of training; TPU: time of pointe use; demographic data and TH exposed in mean ± standard deviation; *: p<0.05 *versus* G1; Student's *t*-test

of the articular injuries (53%) occurred from jump and spin circumstances. The practice of using pointe resulted in about 6% of the cataloged registers (Table 4).

As for the affection circumstances, the main exercises which led to injuries among adults were during specific rehearsal (49%) and choreographies (41%). Considering the request for treatment, there was predominance of the search for medical-therapeutical assistance among underaged dancers (67%) and pointe users (65%). The presence of recurrent symptoms was higher with the use of pointe and among adults (Table 5).

Table 2. Absolute and relative distributions (%) of dancers, according to age, the use of pointe ballet shoes, weekly time of exposure and occurrence of athletic injury

Variables	Group	
	G1 (n=63) n (%)	G2 (n=61) n (%)
Age (years)		
<18	37 (58.7)	34 (55.7)
>18	26 (41.3)	27 (44.3)
Pointe ballet shoe		
No	18 (28.6)	12 (19.7)
Yes	45 (71.4)#	49 (80.3)#
WTE (hours)		
<4 hours	31 (49)	19 (31)*
>4 hours	32 (51)	42 (69)#*

*p<0.05 for horizontal comparisons; #p<0.05 for vertical comparisons; Goodman test for contrast between and within multinomial populations; WTE: weekly time of exposure

About the time away from the activity, it was verified that the onset of affections resulted in similar recuperative intervals among non-users of pointe *ballet* shoes (41±88 days *versus* 13±26 days away from the activity; p=0.06).

DISCUSSION

This study aimed at analyzing the epidemiology of *ballet* injuries, relating some common factors to the history of injuries among practitioners. Under the light of the theme of Science and Sports, it is recognized that the comparison between dancers and elite athletes is difficult, due to evident differences as for the format and periodicity of the training practices[18]. Therefore, it is essential to clarify that the evidences are relevant to a specific kind of public, consisted of classical *ballet* practitioners, from different categories and age ranges.

The presence of injuries is associated to higher body mass. In general, the practice of *ballet* implies continuous improvement of body image, which includes the need for adequate nutritional habits[10] and low rates of body fat[4]. Despite the weight differences, the main factor associated to the occurrence of injuries was the weekly time of exposure to *ballet* practice. The manifestation of extrinsic

Table 3. Absolute and relative distribution (%) of the cases of injury, according to the nature and anatomic locations of the onset

Location	Nature of the injury					
	Muscle n (%)	Tendon n (%)	Articulation n (%)	Bone n (%)	Others n (%)	Total n (%)
Lombar region	4 (13)^{Aa}	0 (0)^{Aa}	2 (6)^{Aa}	0 (0)^{Aa}	2 (40)^{ABa}	8 (9)
UL	0 (0)^{Aa}	1 (6)^{Aa}	0 (0)^{Aa}	0 (0)^{Aa}	0 (0)^{Aa}	1 (1)
LL	25 (83)^{Bb}	16 (94)^{Bb}	32 (89)^{Bb}	0 (0)^{Aa}	3 (60)^{Bab}	76 (85)
Others	1 (3)^{Aa}	0 (0)^{Aa}	2 (6)^{Aa}	1 (100)^{Bb}	0 (0)^{Aa}	4 (5)
Total	30 (34)	17 (19)	36 (44)	1 (1)	5 (6)	89 (100)

UL: upper limbs; LL: lower limbs; $^{A \text{ and } B}$p<0.05 for vertical comparisons; $^{a \text{ and } b}$p<0.05 for horizontal comparisons; Goodman test for the contrast between and within multinomial populations

Table 4. Absolute and relative distribution (%) of the cases of injury, according to the nature and mechanism of the onset

Mechanism	Nature of the injury					
	Muscle n (%)	Tendon n (%)	Articulation n (%)	Bone n (%)	Others n (%)	Total n (%)
Jump	4 (19)^{ABab}	4 (19)^{Aab}	12 (57)^{ABb}	1 (5)^{Aa}	0 (0)^{Aa}	21 (24)
Spin	2 (22)^{ABa}	0 (0)^{Aa}	7 (78)^{Bb}	0 (0)^{Aa}	0 (0)^{Aa}	9 (10)
Stretching	15 (65)^{Bb}	5 (22)^{Aab}	3 (13)^{Aa}	0 (0)^{Aa}	0 (0)^{Aa}	23 (26)
Strength	0 (0)^{Aa}	1 (25)^{Aa}	2 (50)^{Aa}	0 (0)^{Aa}	1 (25)^{Aa}	4 (4)
Pointe	0 (0)^{Aa}	4 (57)^{Ab}	3 (43)^{Aab}	0 (0)^{Aa}	0 (0)^{Aa}	7 (8)
Gesture	7 (53)^{Bb}	3 (23)^{Aab}	3 (23)^{Aab}	0 (0)^{Aa}	0 (0)^{Aa}	13 (16)
Posture	1 (25)^{Ba}	2 (50)^{Aa}	1 (25)^{Aa}	0 (0)^{Aa}	0 (0)^{Aa}	4 (4)
Others	1 (22)^{ABa}	1 (11)^{Aa}	4 (44)^{Aa}	0 (0)^{Aa}	2 (22)^{Aa}	8 (9)
Total	30 (34)	20 (22)	35 (39)	1 (1)	3 (3)	89 (100)

$^{A \text{ and } B}$p<0.05 for vertical comparisons; $^{a \text{ and } b}$p<0.05 for horizontal comparisons; Goodman test for the contrast between and within multinomial populations

factors is associated to the specific movements with high impact, wide range of articular movement and complex movements[15]. The specific *ballet* exercises are usually performed with intensity, duration and a lot of repetition, favoring the onset of injuries[19].

In order to support such, the mechanisms of higher physical injury incidence integrated stretching and jumping activities, common requirements in *ballet*[4,15]. Repetitive movements, the use of pointe *ballet* shoes, the kind of floor and prolonged rehearsals interact in the pathophysiology of injuries by repetitive effort[20,21]. In an similar investigation with athletes, it was found that most part of injuries are caused by excessive repetition, alerting to the interference of auxiliary factors related to excessive use, such as physical and mental fatigue which may compromise strength and coordination[22].

The high prevalence of tendinopathies and articular injuries of the lower limbs corresponded to the specific *ballet* requirements. Numerous authors[20,21,23-25] say lumbar and lower limbs injuries are due to the classical position in dancing, in which hips perform extreme external rotation, with knees in hyperextension, supported by the extremities of the fingers, using the pointe and overloading ankles. Most injury cases resulted in the search for medical-therapeutical support among dancers who use the pointe and, specially, among underaged participants. In general, adult dancers ignore adaptive effects of the continuous overload, neglecting prevention and treatment of smaller injuries[26]. It is very common that adults do not interrupt rehearsal and presentations, even if in pain[27], which may justify the high rate of symptomatic recurrence among adult dancers and pointe users. The precocious performing of excessive exercises after an injury may aggravate even more the conditions[28]. Only from the 1970's on is that the dancers started looking for specific treatments in the medical area[27]. In developed nations, there is an increasing concern with dancing injuries, considering the activities on health education to dancers have commonly been implemented[27].

At last, one should not out rule that the cross-sectional nature of this investigation and the physiological heterogeneity of the studied group may constitute possible methodological biases. Considering the movement specificity of *ballet*, longitudinal studies may provide greater precision on the mechanisms as well as on the circumstances injuries occur. In analogy, the categorization according to the level of physical and motor performance may additionally contribute to the characterization of injuries among dancers.

Table 5. Absolute and relative distribution (%) of the cases of injury, according to request for treatment, symptoms reccurrence and onset circunstances, age and use of pointe ballet shoes

Variables	Pointe		Age	
	No n (%)	Yes n (%)	<18 n (%)	>18 n (%)
Treatment				
No (1)	9 (53)^{Aa}	25 (35)^{Aa}	13 (33)^{Aa}	21 (43)^{Aa}
Yes (2)	8 (47)^{Aa}	47 (65)^{Ba}	27 (67)^{Ba}	28 (57)^{Aa}
Symptom recurrence				
No (1)	3 (8)^{Aa}	33 (26)^{Ab}	21 (58)^{Aa}	15 (42)^{Ab}
Yes (2)	14 (92)^{Ba}	39 (74)^{Bb}	19 (36)^{Aa}	34 (64)^{Bb}
Circunstance				
Bar	3 (18)^{Aa}	17 (24)^{Aa}	15 (38)^{Aa}	5 (10)^{Ab}
Specific	6 (35)^{Aa}	33 (46)^{Aa}	15 (38)^{Aa}	24 (49)^{Ba}
Choreography	8 (47)^{Aa}	22 (31)^{Aa}	10 (24)^{Aa}	20 (41)^{Ba}

$^{A \text{ and } B}p<0.05$ for vertical comparisons; $^{a \text{ and } b}p<0.05$ for horizontal comparisons; distinct characters reveal significant difference, considering A,B and a<b. Goodman test for the contrast between and within multinomial populations

CONCLUSION

The articular injuries of the lower limbs are the main affections resulting from classical *ballet*. Differently from the initial hypothesis, the weekly time of exposure is associated to the onset of injuries among dancers.

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