

USE OF SNEAKER RUSH AND SYMPTOMS OCCURRENCE OF SKELETAL MUSCLE (SME) IN BALLERINA



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ABSTRACT

Introduction: Technical literature shows high frequencies of injuries occurring in classical ballet dancers; however, only limited information about the permanent effects of chronic diseases are mentioned. **Objective:** To compare the presence of MSD among dancers who wear pointe shoes and those who do not. **Methods:** The research was conducted at the 27th Festival of Joinville in Santa Catarina. The study had the participation of 111 dancers, 88 of whom wore pointe shoes while 23 did not. Specific procedures were used to obtain information related to MSD and foot injuries caused by dancing. **Results:** The most affected parts were the knees (29.7% with pointe shoes *versus* 39% without), spine (26.4% with pointe shoes *versus* 22% without), and ankle/foot (20% with pointe shoes *versus* 12.2% without). Through odds ratio and respective confidence intervals (IC95%), the study identified protection factor in the knees (0.24; CI95% – 0.09-0.64) and legs (0.11; CI95% – 0.02-0.65) for dancers who wear pointe shoes. It was found that the risk of injuries in specific structures of the foot is significantly higher among those dancers. In this case, the appearance of bunions (9.74; CI95% – 1.25-75.99), calluses on the toes (3.46; CI95% – 1.29-9.27) and the association of the three (4.47; CI95% – 1.69-11.83) were those that showed an increased risk factor compared to dancers who do not stand en pointe. **Conclusion:** The use of pointe shoes in elite Brazilian dancers was associated to lower occurrence of MSD in the knee and leg, however it was strongly associated to foot injuries

Keywords: pain, injuries, musculoskeletal system.

INTRODUCTION

Ballerinas wear specific footwear for classical ballet, slippers or pointe shoes. They are made of leather, fabric satin, special paper, insoles and glue^{1,2}. Although different ballet aspects have faced significant evolution over the years, ballerinas still dance with a cardboard structure hardened with glue. Colluci and Klein³ state that hundreds of injuries and bone deformities are observed due to the primitive manufacturing of this footwear. Maintenance of this design is attributed to the belief that discomfort and sore feet are consequences of the task under consideration, a reason why the association between pain and use of pointe shoes is investigated.

This footwear has a rigid insole and a vamp (structure of the shoes which nests the toes), which are particularly uncomfortable for the toes, since they must fit in this space, and then, reach complete plantar flexion, which characterizes the “en pointe position”^{2,4}. According to Kadel¹ the classical ballet practitioner remains too much time at pointe position, overloading not only the intrinsic muscles of the feet, but also the ones which surround the ankle, since they are tremendously recruited. Body weight is supported on the ankle articulation, together with the tips of the first and second toes. When the ballerina is at this position, the plantar pressure on the pointe is of 1.5 mega pascal.

Cunningham *et al.*⁴ and Kadel¹ add that the vamp is projected to guarantee feet protection, and when it loses its structural integrity, it increases risk of injuries. Thus, toes, plantar arches and anterior border of the feet are compressed and built the main support and sustaining site to the ballerina, resulting in

neuromuscular, physiological and bone stress. Therefore, Hiller *et al.*⁵ state that the use of pointe shoes leads to the incidence of injuries, as well as repetitive training and long rehearsal hours are factors which interact and cause injuries by effort excess⁶.

Concomitantly, ballet and modern dance practitioners present high incidence of injuries (67% to 95% and 17% to 24%, respectively), out of which, the lower extremity equals to 75% of the cases^{1,7}. Bronner *et al.*⁸ add that overuse is responsible for the majority of the injuries (60%-76%). Although the literature mentions high frequencies of injuries among ballerinas who dance on pointe, information on the permanent chronic effects of these injuries is scarce⁹.

Considering the high prevalence of injuries in dance and a technical condition of risk for installation of injuries, the aim of this study was to compare the musculoskeletal symptoms (MSS) and bone deformities of ballerinas who wear and not wear pointe shoes.

METHODS

Causes and study site

The research was carried out at the 27th Joinville Festival, in Santa Catarina, the main Brazilian event of the field, and hosts participants from all regions of the country and from abroad, being cited in the *Guinness Book*, in 2005 as the biggest dance festival in the world¹⁰. Before the performance, a board of specialists of national prestige classifies the dancers in: (i) competitive participants on the main stage, (ii) competitive participants “on Slippers” on side stage, (iii) non-competitive presentations on open stage

distributed around the city. The competitive show on the main stage is composed of eight nights of events, in which the dance groups and schools perform in seven different modalities: classical ballet (including repertoire), contemporary dance, tapping, jazz, street dance and popular dances.

173 dancers, choreographers and teachers, who participated in the competitive part on the main stage, all of them with more than 10 years of practice, have been identified in the Festival for the study. Out of this number, 111 participants were reported as female (65%) out of which, 88 were ballerinas who wore pointe shoes and 23 did not. 25 former ballerinas and 37 male ballet dancers were excluded.

The Ethics Committee in Research of the State University of São Paulo – UNESP approved the study (File 1050/46/01/10).

Field procedures

Collection was performed during the Competitive Exhibition at the moments of stage rehearsal, when the participants had set schedule to rehearse their routines on the day and premise of the competition. As soon as they ballerinas arrived, the researcher introduced herself to the person in charge for the group and explained about the aims of the research. During warm-up and stretching, or after the stage rehearsal, the ballerinas who agreed on participating were interviewed. Out of the 36 approached dancers, four did not agree on participating and all of them excused themselves due to being busy or late for appointments.

Evaluation

The ballerinas answered a protocol which had personal information (name, number of protocol, age, telephone number and e-mail address), professional background (position/function in the school/group, number of years in the dance group), as choreographer or teacher, time dedicated to the different dance styles, number of classes per week, tie of each sessions and time she made use of pointe shoes (protocol adapted from Schon and Weinfeld⁶).

Information concerning the MSS was collected from the completion of a protocol adapted from the Nordic Questionnaire of Musculoskeletal Discomfort, proposed by Campoy *et al.*⁹. In this study, MSS was considered as all episodes where the practitioner had referred pain, numbness or weight feeling, related to practice of physical exercises. The person should inform if had felt any of these symptoms over the last month, in a persistent manner, on different sites. Additionally, the individual also informed about the type of discomfort (pain, weight sensation or numbness), intensity (light, moderate or heavy), duration (during the movement, constant and after the movement) and if the pain was local or diffuse for each body site. This model was adapted from Coury¹¹ and used in research with population of the same nature of the one in this study¹². The last step was adapted from the protocol by Grego *et al.*¹³ which contained information about the onset of calluses on the toes. Values concerning weight and height were used for the calculation of the body mass index (BMI).

DATA ANALYSIS

Numerical data were expressed as means and standard deviation, as well as the Student's *t* test for independent samples established comparison between them. Category data were treated with the Chi-square test about the associations (for 2 x 2 con-

tingence tables, the Yates correction was used) and binary logistic regression expressed their magnitude through values of chance ratio (CR) and its respective confidence intervals of 95%. Statistical significance was set at $p < 0.05$ and the *software* SPSS (version 13.0) was used to process the analyses.

RESULTS

Concerning the use of pointe shoes or slippers, there were no differences for age, height or time of dancing. However, there was difference for weight, body mass index (BMI) and time of weekly training. Ballerinas who do not wear pointe shoes present higher BMI and have lower training weekly volume (table 1). The sites mostly mentioned with MSS were spine (42.3 [CI95%: 33.1-51.5]), knee (42.3 [CI95%: 33.1-51.5]) and ankle/foot (30.6 [CI95%: 22.1-39.2]). According to the use of footwear, there was difference for the onset of MSS for the knee site (Use 35.2% and no use 69.6%; $p = 0.006$) and leg (Use 2.3% and No use 17.4%; $p = 0.012$). Figure 1 presents the association between the use of pointe shoes and the percentage of referred MSS. When compared with the group which did not inform any MSS, there was higher use of slippers in the groups with 2 MSS ($p = 0.016$) and ≥ 3 ($p = 0.010$) MSS, while there was similarity with the group which only had 1 MSS ($p = 0.348$).

Table 2 illustrates the association between presence of musculoskeletal symptoms according to body sites of lower extremities and the use of pointe shoes. Regarding the hip, thigh and ankle/foot structures, no significant association was observed; however, for the knees (CR= 0.24 [0.09-0.64]) and legs (CR= 0.11 [0.02-0.65]) the ballerinas who wore pointe shoes presented lower onset of MSS.

Finally, in table 3 it was observed that the risk of being affected by injuries specific to the foot structures is significantly higher among ballerinas who wear pointe shoes. In that case, the onset of bunions (CR= 11.5 [1.43-92.1]), calluses on the toes (CR= 4.52 [1.58-12.9]), calcaneal calluses (CR= 12.9 [1.57-106.5]) and the association of the three (CR= 5.74 [2.01-16.39]) were statistically significant as demonstrated in the chance ratios presented in table 3.

DISCUSSION

The participants of the research presented intense weekly training routine, where the ones who wore pointe shoes were more remarkable, presenting longer time (14h/w) than the ones who did not wear pointe (7h/w). Moreover, both groups presented long time of experience in dance. Such results are similar to the ones presented by previous studies^{14,15} in which professional dancers reported high weekly time of practice, as well as data of previous time of practice corroborate the high level of the sample analyzed. In our study, ballerinas who did not wear pointe shoes presented higher number of MSS. Likewise, Walter *et al.*¹⁶, when investigated the possible causes for injury on the lower limbs of ballerinas, approached the relation between ground reaction force for jumps in ballet and the type of footwear. Each participant of the research performed 12 basic jumps of classical ballet on a force platform, performing six with slippers and six with pointe shoes. It was concluded that the ground reaction force was significantly stronger when the ballerinas landed with slippers on than when they wore pointe shoes ($p = 0.003$). There was no significant difference in height of the jump between the two footwear conditions. The authors believe that increase in ground reaction force was mainly produced

Table 1. General characteristics according to the use of pointe shoes.

Characteristics	With pointe shoes	No pointe shoes
	Mean ± SD	Mean ± SD
Age (years)	26.8 ± 7.8	21.0 ± 3.9
Weight (kg)	53.8 ± 6.1	57.7 ± 5.6*
Height (m)	1.6 ± 0.1	1.6 ± 0.1
BMI (kg/m ²)	20.2 ± 1.9	21.6 ± 1.7*
Time of dancing (years)	19.7 ± 7.8	14.7 ± 3.4
Weekly training (minutes)	874.1 ± 745.3	416.1 ± 381.1*
Time of use of pointe shoes (years)	10.1 ± 5.9	----
MSS by body site		
Elbow/wrist (n [%])	1 (1.1)	2 (8.7)
Spine (n [%])	38 (43.2)	9 (39.1)
Neck/shoulder (n [%])	7 (8)	1 (4.3)
Hip (n [%])	11 (12.5)	3 (13)
Thigh (n [%])	7 (8)	1 (4.3)
Knee (n [%])	31 (35.2)	16 (69.6)**
Leg (n [%])	2 (2.3)	4 (17.4)***
Ankle/foot (n [%])	30 (34.1)	4 (17.4)

MSS= musculoskeletal symptoms; SD = standard deviation; * = Student's *t* test with *p* < 0.05; ** = Chi-square test with *p* < 0.05; ***= exact Fisher's test with *p* < 0.05.

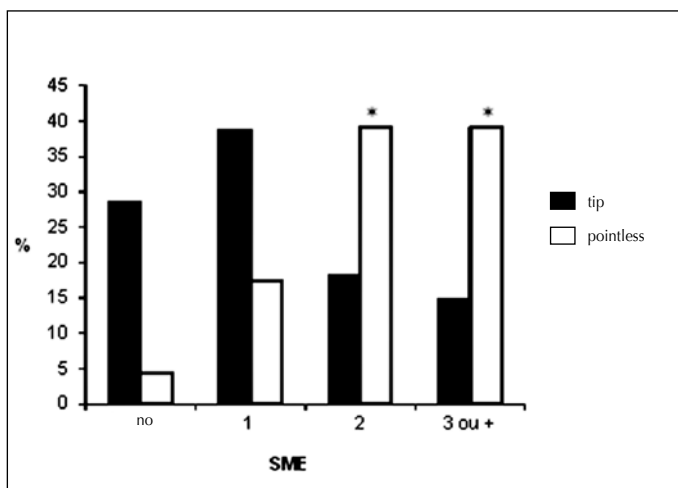


Figure 1. Distribution of the percentage of musculoskeletal symptoms in ballerinas who wear pointe shoes.

Table 2. Association between the onset of musculoskeletal symptoms on different body sites and the use of pointe shoes.

Body sites	Type of footwear	Parameters of logistic regression	
		CR	(CI 95%)
Hip	Slipper (reference)	1.00	
	Pointe shoes	0.95	(0.22 – 4.03)
Thigh	Slippers (reference)	1.00	
	Pointe shoes	2.68	(0.29 – 24.37)
Knee	Slippers (reference)	1.00	
	Pointe shoes	0.23	(0.08 – 0.65)
Leg	Slippers (reference)	1.00	
	Pointe shoes	0.11	(0.01 – 0.82)
Ankles/ feet	Slippers (reference)	1.00	
	Pointe shoes	2.96	(0.88 – 9.98)

CR = chance ratio adjusted by time of dancing and age; CI95% = confidence interval of 95%.

Table 3. Association between feet injuries and use of pointe shoes in ballerinas.

Injury	Type of footwear	Parameters of logistic regression	
		CR	(CI 95%)
Bunions	Slippers	1.00	
	Pointe shoes	11.5	(1.43-92.1)
Calluses on toes	Slippers	1.00	
	Pointe shoes	4.52	(1.58-12.9)
Calcaneal calluses	Slippers	1.00	
	Pointe shoes	12.9	(1.57-106.5)
Associated	Slippers	1.00	
	Pointe shoes	5.74	(2.01-16.39)

Notte: CR= chance ratio adjusted by time of dancing and age; CI95% = confidence interval of 95%.

by the type of footwear worn. This finding can be an explanation for the fact ballerinas who wear slippers complain more frequently about musculoskeletal symptoms. In our study it was found that the onset of specific injuries on the foot structures is significantly higher among ballerinas who wear pointe shoes. Similarly, a previous study involving 122 ballerinas from Bauru, SP (more than three years of practice), confirmed that the use of pointe shoes was associated with the onset of calluses (RO = 4.93); blisters (RO= 2.60); bunions (RO= 2.90) and acute injuries (RO= 2.64)¹³.

Menezes *et al.*¹⁷ correlated the anthropometric characteristics of the feet of ballerinas with orthopedic disorders. They investigated 54 ballerinas from Aracaju, SE, Brazil and found that 86% of the ones who wore pointe presented calluses against 26% of the ones who did not wear pointe.

Concerning this issue, Bambirra¹⁸ considers that 11 or 12 old children are already prepared to receive force support on their feet. Pointe training should start when the lower extremity is sufficiently strong to keep correct balance and alignment without help provided by the contact of the entire foot on the ground. The body support on the body on the pointe is not only a technical evolution but also an adaptation of the body to a new kind of balance, with fortification of bones, tendons, ligaments and muscles¹⁹. If the recommendations about the footwear and the physical work of the feet are not followed, pain and difficulty in maintaining the position will occur, compromising the stability and integrity of the anatomic structures of the feet.

Moreover, if we insist on the error, there will be damage to health and difficulty in performing the pointe technique¹⁸. In the present study, the knee site was target of a large number of complaints of musculoskeletal pain. Predominance of injuries in that joint was also observed by other researchers^{15,20-23}. Peña *et al.*²⁰, investigating 47 dance students, verified that pain on the knee (31.9%) was the most frequent. In that case, the clinical-kinesiological examination was performed, which diagnosed the Patellofemoral Pain Syndrome as the most frequent. According to Leite²², it is a common problem among active individuals and accounts for more than 50% of the complaints on the knee of dancers. Although the etiological factors of this syndrome are unknown, the biomechanical alterations of the lower limb are mentioned as the main cause, which derive from static and dynamic imbalance. Concerning static balance, abnormalities such as excessive subtalar pronation, increase of the Q angle, external tibial torsion and retraction of the lateral retinaculum are reported. Among the imbalance of the dynamic stabilizers we can

mainly mention the medial and lateral components of the quadriceps muscle, and, more recently, the oblique portion of the vastus lateralis^{22,24}. The regression model pointed out the use of pointe shoes as a protection factor for knees and legs. An explanation for such fact is that many positions on pointe in classical ballet have in common the extremely decreased support basis, which requires great muscular and neurophysiological effort²⁵. This effort may bring consequent muscular strengthening representing protection for the pointe shoes user²⁶. Once again with this view point, Albisetti *et al.*²⁶ state that, due to repetitive efforts of the lower extremity, the patellar disorders are common among ballet dancers. After a case study, they attributed deficiency of the vastus medialis as one of the factors which cause the patellofemoral syndrome, and therefore, proper strengthening of this muscle could avoid the development of this syndrome.

Liederbach *et al.*²⁷ studied the anterior cruciate ligament (ACL) in classical ballet and modern dancers for five years in four different dance groups. Out of the 298 investigated dancers, 12 experienced one ACL injury.

In 92% of the cases, the injury mechanism was the one-legged jump. There was no difference between sex, race, use of contraceptive or dance groups. On the other hand, the modern dance ballerinas who usually dance barefoot or with slippers presented relative risk three to five times higher than the observed in classical ballerinas who wear pointe shoes. The authors conclude that the many jumps and skills performed by the classical ballerinas in their classes and rehearsal can protect them from the ACL injury. The low back region was also target of many MSS. Despite that, the injuries reported in this region seem to occur with lower frequency than the one observed in the general population²⁸⁻²⁹. Capel *et al.*²⁹ investigated 40 ballerinas aged between 18 and 31 years with more than 12 years of practice in dancing, and compared them with a

control group (20 women). All the participants of the study were submitted to magnetic resonance imaging of the lumbar spine. They observed that 45% of the control group presented degeneration of the intervertebral discs in women, while the dance group, 32.5%. It was concluded that dance cannot be considered a risk factor for degenerative intervertebral discs in women. Grego *et al.*¹² investigated the onset of musculoskeletal injuries among classical ballet practitioners, ballerinas without classical background and physical education present more complaints of low back pain (21.6%) than the classical ballerinas (14.8%) and non-classical ballerinas (0%). Higher frequency of low back pain was found by Dore and Guerra³⁰ when assessing 141 professional ballet dancers mean age of 26.1±6.1 years. The most reported regions were low back with 85.8% and knees with 59.6% of the participants of the study. These findings highlight that this body region may suffer overload during ballet practice, and, therefore, deserves special attention from the trainers and health professionals.

It is worth mentioning that the transversal outlining of the study was a limitation since it does not allow correlate causes among the assessed variables. Additionally, further prospective studies involving this issue in an attempt to investigate groups more similar concerning number of participants in each sample group are suggested.

CONCLUSION

In Brazilian elite ballerinas the use of pointe shoes was associated with lower onset of MSS on the knee and leg sites; however, their use is strongly associated with the onset of feet deformities.

All authors have declared there is not any potential conflict of interest concerning this article.

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