



Musculoskeletal Disorders among Greek Professional Ballet Dancers

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MT, EB and KP designed the study, wrote the protocol, performed the statistical analysis and revised subsequent versions. Authors KF and ET guided and managed the analyses of the study findings. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine the incidence rate, type and anatomical distribution of musculoskeletal disorders and injuries of Greek professional Ballet Dancers.

Study Design: Cross-sectional study.

Place and Duration of the Study: Greek National Opera, Athens, Greece, 2 months.

Methods: A self-administered questionnaire, containing primarily items related to the presence of injury and the body regions involved was given to all elite ballet dancers working in the Greek National Opera.

Results: 31 ballet dancers (11 males, 20 females) participated in the study, providing a response rate of 59.61%. 62% of dancers (mean age 36 years) reported at least one musculoskeletal injury during the last year. In total, 98 injuries were registered. 65% of all injuries were reported to be due to overuse and 35% were traumatic. The incidence of injury among professional dancers was 1.10 and 1.55 injuries per 1000 dance hours in males and females, respectively. The most frequent injury location was the neck and low back area (61.3%) in both sexes among the professional

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dancers followed by the shoulders (48.4%) and ankles (45.2%). Ninety four percent (94%) of the injured dancers needed physiotherapy and only 23% needed surgery. The majority of injured dancers (55%) were absent from dance training for more than a week after the injury. Dancers believed that several factors were associated with risk of injuries, including training (90%) and muscle weakness (74%).

Conclusions: Ballet dancers have high prevalence rates of musculoskeletal injuries and disorders. The findings of this study suggest that there is a need to apply primary injury prevention schemes in Greek ballet dancers.

Keywords: Musculoskeletal disorders; injuries; ballet dancers.

1. INTRODUCTION

Ballet is a sport that places extreme physical demand in the human body [1]. Ballet dancers are described as athletes and are being compared to high competitive athletes because they perform complex, physically demanding routines and are subjected to long periods of training [2,3]. Dancing is a demanding and complex form of exercise, where high levels of muscle tension are being developed [4]. As in sport, dance performance is not a single act [5]. It depends on a number of technical, medical, physiological, psychological, nutritional, environmental and economic elements [4]. Professional dancers must be experts in the aesthetic and technical aspects of the art [6,7]. A successful career in ballet dancing demands that the dancer should be flexible and strong. Dancers also have to be psychologically prepared to handle the stress of critical situations [5].

Classic ballet training, rehearsal, and performance do not elicit significant stimulus to result in increased aerobic fitness levels [8]. In general, ballet dancers consistently demonstrate reduced fitness levels than other athletic populations [4,9]. They also have low body weights and low body fat percentage [8]. Appropriate active mass and body fat, are essential ingredients for optimising physical performance [5]. As for somatotype, male dancers showed predominance of mesomorphy over female dancers who showed dominance of ectomorphy [10].

Ballet dancers are particularly susceptible to a wide variety of musculoskeletal injuries [11] that can potentially disrupt performance and curtail their career [12]. The prevalence of injury is high in professional ballet dancers with a significant percentage not reporting their injuries for a variety of reasons [13]. The fear of injury is universal among dancers because injuries can lead to permanent disability and the end of their ballet career [14].

There is a reported high prevalence and incidence of lower extremity and back injuries in ballet dancers [15]. Many studies report lower extremity injuries [1,2,11,16]. According to Smith et al. [1] the most prevalent musculoskeletal disorders include: hamstring strain, foot/ankle tendinopathies and generalized low back pain. Researchers indicate also sex-based differences. Sobrino et al. in their study found that the number of overuse injuries is higher in women than men [17].

As far as Greece is concerned, there is no scientific epidemiological evaluation of injuries about professional ballet dancers. Thus, the aim of the present study is to examine the incidence rate, the types and anatomical distribution of musculoskeletal disorders among Professional Ballet Dancers. Secondary aim is to investigate, gender differences across the sample obtained.

2. METHODS

2.1 Participants

Elite ballet dancers (both male and female) working in Greek National Opera were included in the study, which was conducted between January and February 2016. Ethical approval was provided by the ethics committee of the School of Health and Welfare-Technological Educational Institute of Western Greece. All the ballet dancers were informed about the procedure prior to the completion of the questionnaires and gave their written consent for inclusion in the study.

2.2 Sample

Thirty-one professional ballet dancers, both male (n=11) and female (n=20), participated in the current study (Table 1).

Their age ranged from 21 to 50 (36,1±8,1) years and their weekly dance training ranged from 15 to 40 hours. The height ranged from 150 cm to

191 cm (172,5±7,8) while weight ranged from 44 to 78 kg (58,48±8,8).

2.3 Questionnaire Development and Administration

Injuries were recorded by the main author (TM), via interview, using a specific questionnaire, which comprised two sets of standardised questions. The first set was the Greek version of the Standardized Nordic Questionnaire [18]. The Standardized Nordic Questionnaire divides the human body into nine anatomical regions (neck, shoulder, elbow, hand/wrist, upper back, lower back, hip/thigh, knee, and ankle/foot) and a body chart was additionally included to easily depict the affected areas. Participants were asked whether they had pain and discomfort in the indicated areas during the preceding 12 months and if those symptoms prevented their normal activity during the last year as well as the preceding week. The second set of questions comprised a self-administered questionnaire for obtaining the socio-demographic variables and the potential risk factors. The questionnaire included the following 10 items: age, gender, weight, height, average weekly dancing hours, doctor diagnosis and treatment (conservative, operative) of the main injury, absence time from practice or performance, the personal opinions of the participants about the involved risk factors of their pain/disorders and their participation in physiotherapy sessions for handling their problem. Severity of injuries was classified into three categories based on the time of absence from dancing; minor for less than 1 week, moderate from 1 week to 1 month and major for longer than a month [12].

2.4 Procedure

Musculoskeletal injuries data was collected by personal interviews of the ballet dancers. All the ballet dancers were informed about the procedure prior to the completion of the questionnaires and consented to their inclusion in the study.

2.5 Statistical Analysis

Analysis consisted of descriptive statistics and data was analyzed with SPSS (version 17). Dancing exposure was recorded and calculated

by the researchers, using detailed performance schedules that dictated activities per day of dancers. Injury incidence was calculated as the number of injuries per 1,000 dancing hours. Between genders comparison was tested with the student's t-test for independent samples and the significance level was set at .05.

3. RESULTS

3.1 Participants' Characteristics

Questionnaires were completed by 31 dancers (response rate 59.61%). The physical and dancing characteristics of the participants are presented in Table 1.

3.2 Prevalence of Musculoskeletal Injury

Sixty-two percent (62%) of dancers reported at least one musculoskeletal injury during the last year. Among professional dancers 98 injuries (among 31 dancers) were reported. The incidence of injury among professional dancers was 1.10 and 1.55 injuries per 1000 dance hours in males and females, respectively. Two thirds (65%) of overall injuries were reported to be due to overuse [defined as any injury with a gradual onset, by repeated microtrauma], [12] and one third was traumatic.

Prevalence rates of injuries were higher in the spine (neck and low back: 61.3%), followed by the shoulders (47.6%) and ankle/foot (40%). The area with the less prevalence was the elbow (12.9%). There were differences between genders regarding the main area of pain and discomfort. The lower back area had the higher prevalence rate in women (70%), whereas the neck area (56.4%) prevailed in men. However, no statistical significant differences between genders for low back or neck was reported (Table 2).

The 12-month prevalence rate of disorders in elite dancers was 58.1% in the lumbar area, followed by the neck (45.2%), shoulders (29%), foot/ankle (32.3%) and hips (29%). The area with the lower prevalence was the elbow again (9.7%) (Table 3). The most frequent areas of pain or discomfort in female participants were the low back area (70%), while men tended to complain mostly for the neck area (45.5%), however the difference did not reach statistical significance ($p=0.06$).

Table 1. Characteristics of ballet dancers

		Frequency (N)	Percentage (%)
Sex	Men	11	19.1%
	Women	20	80.9%
Age (years,mean+SD)	20-39 years	21	67%
	40-58 years	10	33%
	Mean 33,1 + 8,1	31	100%
Height	150-191 cm	31	100%
	(172,5±7,8)		
Weight	44-78 kg	31	100%
	78 kg (58,48±8,8)		

Table 2. Prevalence rates of musculoskeletal disorders among professional ballet dancers

Body region	Women 20 (64.5%)	Men 11 (35.48)	Total 31 (100%)	P value
Neck	12 (60.0%)	7 (63.6%)	19 (61.3%)	.92
Shoulder/s	10 (50.0%)	5 (45.5%)	15 (48.4%)	.80
Elbow	1 (5.0%)	3 (27.3%)	4 (12.9%)	.07
Wrist/hands	3 (15.0%)	4 (36.4%)	7 (22.6%)	.17
Thoracic area	7 (35.0%)	2 (18.2%)	9 (29.0%)	.32
Low back area	14 (70.0%)	5 (45.5%)	19 (61.3%)	.17
Hip/s	6 (30.0%)	5 (45.5%)	11 (35.5%)	.38
Knee/s	6 (30.0%)	3 (27.3%)	9 (29.0%)	.87
Foot/ankle	9 (45.0%)	5 (45.5%)	14 (45.2%)	.97

Table 3. 12 months prevalence rates of musculoskeletal disorders among professional ballet dancers

Body region	Women 20 (64,5%)	Men 11 (35.48)	Total 31 (100%)	P value
Neck	9 (45.0%)	5 (45.5%)	14 (45.2%)	.97
Shoulders	6 (30.0%)	3 (27.3%)	9 (29.0%)	.87
Elbows	1 (5.0%)	2 (18.2%)	3 (9.7%)	.23
Wrist/hands	2 (10.0%)	3 (27.3%)	5 (16.1%)	.21
Thoracic area	6 (30.0%)	1 (9.1%)	7 (22.6%)	.23
Low back area	14 (70.0%)	4 (36.4%)	18 (58.1%)	.06
Hip/s	6 (30.0%)	3 (27.3%)	9 (29.0%)	.87
Knee/s	4 (20.0%)	3 (27.3%)	7 (22.6%)	.64
Foot/ankle	5 (25.0%)	5 (45.5%)	10 (32.3%)	.24

Over the last week period, the most prevalence injury site was again the lumbar area and the neck (29%), followed by the shoulders (22.6%) and foot/ankle (19.4%). The elbow was the area with the lowest injury occurrence (3.2%) (Table 4). The only area who presented statistically inter-gender differences regarding last week pain, was the foot/ankle region ($p=0.04$), with female dancers being more injury-prone.

3.3 Causes and Consequences of Injuries

Factors, the dancers perceived as more risky for injuries were training scheme (90%), followed by

muscular weakness (74%) and environmental factors (hard floors, barefoot dancing) (71%). Age was perceived as the less prevalent influential factor (52%) (Table 5).

The majority of the musculoskeletal injuries were classified according to their severity as moderate. Fifty-five percent (55%) of the disorders resulted in absence from dancing longer than a week.

Ninety-four percent of the dancers (94%) did receive physiotherapy for their musculoskeletal pain/disorder and only 23% of the dancers answered that needed surgery for their injury.

Table 4. 7 days prevalence rates of musculoskeletal disorders among professional

Body region	Women 20 (64,5%)	Men 11 (35.48)	Total 31 (100%)	P value
Neck	6 (30.0%)	3 (27.3%)	9 (29.0%)	.87
Shoulders	5 (25.0%)	2 (18.2%)	7 (22.6%)	.66
Elbows	0 (0.0%)	1 (9.1%)	1 (3.2%)	.17
Wrists/hands	2 (10.0%)	0 (0.0%)	2 (6.5%)	.27
Thoracic area	4 (20.0%)	1 (9.1%)	5 (16.1%)	.37
Low back area	7 (35.0%)	2 (18.2%)	9 (29.0%)	.32
Hip/s	2 (10.0%)	1 (9.1%)	3 (9.7%)	.93
Knee/s	2 (10.0%)	0 (0.0%)	2 (6.5%)	.27
Foot/ankle	6 (30.0%)	0 (0.0%)	6 (19.4%)	.04

Table 5. Causes of musculoskeletal injuries among professional ballet dancers

Causes/Risk factors	Total	Women	Men
Training factors	90%	95%	82%
Muscle weakness	74%	16%	64%
Bad posture/alignment	55%	70%	27%
Anatomical factors	55%	60%	45%
Psychological factors	55%	55%	55%
Environmental factors	71%	80%	55%
Age	52%	55%	45%
Technique	65%	75%	45%

The majority of research on ballet dancer injuries focus on the lower extremity [1,21,22]. Back and upper extremity injuries are considerably less frequent [23,24]. A 19-week study among professional ballet dancers in the Norwegian National Ballet revealed that the majority of injuries involved the foot and ankle [25]. In the present study 32% of the dancers experienced musculoskeletal disorder within the last year. The etiology of common lower extremity disorders include an incorrect turnout; soft tissue imbalances; reduced quadriceps performance; "rolling in of the foot;" inversion sprains; and frequent pliés, pointé, and demipointé work [20]. A systematic review by Hinkapie et al., (2008) evaluated 15 cohort studies, 13 cross-sectional studies, and 1 validation study performed since 1966. The authors of that review found a high prevalence of lower extremity and back injuries in dancers, with soft-tissue and overuse injuries dominating [15].

In women, the area with the higher prevalence rate is the low back (70%), while in men the neck area (56,4%) is prevailing, however, without statistical significant differences amongst them. Sex-related differences were somewhat more obvious in other studies [17,26,27]. Smith et al [1] showed that male professional dancers display a relatively higher frequency of acute injuries, which account for half of their injuries [1]. These differences may be due to the small number of participants in our study.

In the Greek National Ballet, more than half (55%) of the disorders resulted in a longer than a week absence from either training or performance. In the study by Byhring and Bo [25] most injuries were of mild to moderate severity and forced considerably less dancers (16%) to abstain from their ballet duties. Ballet dancers exhibit a consuming passion for dance that makes a decision to stop dancing for injury or other reasons exceedingly difficult [28].

4. DISCUSSION

The highest prevalence of disorders in professional ballet dancers according to body site in this study was the low back followed by the neck, shoulders and ankle/ foot. In 1989, Bowling [19] observed that professional ballet dancers had predominantly chronic injuries and that the cervical, lumbar, and ankle regions were mostly affected. Spinal conditions were reported to result from hyperextension and hyperlordosis of the lumbar spine as well as due to the psoas insufficiency syndrome [20].

In the present study the incidence of injury among professional dancers was 1.10 and 1.55 injuries per 1000 dance hours in males and females, respectively. This is in accordance with Smith et al. (2016), who systematically reviewed the respective literature and reported injury incidence and/or prevalence in more than 1365 amateur and 900 professional dancers. Smith et al's [1] incidence of injury among professional dancers was 1.06 and 1.46 injuries per 1000 dance hours in males and females, respectively; which is comparable to ours.

The majority of the ballet dancers in this survey (94%) did receive physiotherapy for their musculoskeletal pain/disorder. Ballet dancers routinely engage in therapeutic practices that manage the injuriousness and precariousness of their professional dancing activities [27]. The major dance companies, now have substantial therapeutic and counselling services with physiotherapy departments consisting of chartered physiotherapists, sports masseurs, Pilates and body conditioning instructors [29].

Factors, the dancers perceived as potentially injury-inducing, were related to training (lack of warm-up exercise, Repetitive jumping), muscle issues (weakness, weak eccentric strength of leg muscles), environmental factors (footwear and surfaces). There is evidence to support the relation of all these factors with higher risk for injury in ballet dancers [25]. Byhring and Bo [25] in their study on Norwegian dancers came to the same conclusions regarding factors related to training. An investigation of Swedish ballet dancers suggested that inadequate physical training was a primary contributor to dance injuries. In another study professional ballet dancers who participated in a fitness program apart from their dance technical training showed an increase in maximum oxygen uptake, as well as decreased psychological stress, in comparison to a control group of dancers who did not pursue a fitness program [28].

Faculty techniques is also an important factor. "Turnout" – externally rotating the hips and lower extremities to place the feet as close as possible to an ideal angle of 180° with each other – is a fundamental component of ballet [28]. The single most important anatomical factor in classic ballet is a proper turnout of the lower extremities. But, many dancers force this position beyond their normal limits [28] If poor technique, such as an incorrect turnout (inadequate hip external rotation), can be corrected through appropriate instruction and treatment of tight structures in the hip, many lower limb and lumbar spine syndromes are believed to be prevented [10].

The primary limitation of this study was the limited number of professional dancers. While similar studies analyze data from 98 to 137 participants [16,30,31,32] a much smaller sample was used in the current study. It was conducted in the Greek National Opera, in Athens, Greece, which is the sole professional elite dancers workplace in Greece, hence this type of survey in

this country is inherently of relatively limited power. Furthermore the lack of any objective diagnostic criteria (plain radiographs, magnetic resonance imaging), precludes analysis of the effect of dancing on the health of the dancer's body. Smith et al. highlights that in many studies there is lack in objectives measurement [1].

It is also important to note that in this survey no association was made between the rank of the dancer or the weekly training hours with the reported injuries. Further research could enlighten these points. Because of the high number of injuries suffered by dancers, as well as the intensity and competitiveness of their profession, studies like this, recording and classifying the injury occurrence, is an important prevalence 'tool' to health professionals (2). Susceptible anatomical areas are more identifiable and prevention strategies can be more targeted to these areas.

5. CONCLUSIONS

Ballet dancers are high-performance athletes with high prevalence of injuries and disorders. In this study the incidence of injury among professional dancers was 1.10 and 1.55 injuries per 1000 dance hours in males and females, respectively. In the current study, the main cause of musculoskeletal disorders was limited to factors related to training.

This finding supports the necessity to introduce focused interventions to reduce the risk of injury in professional ballet dancers. Injuries represent an important health problem among dancers, which calls for further research on specific risk factors being explored for injuries and chronic pain. Further research should investigate in depth the profile of musculoskeletal disorders in elite professional ballet dancers and the effectiveness of focussed prevention programmes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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