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Research Article / Araştırma Makalesi

Musculoskeletal injury profile of ballet dancers

Bale dansçılarının kas-iskelet sistemi yaralanmala profili

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ABSTRACT

Objective: The aim of our study is to examine the injury profiles of ballet dancers.

Materials and Methods: Dancers of The State Opera and Ballet Directorate who volunteered for the study applied to Ege University Faculty of Medicine, Department of Sports Medicine. Age, gender, height, body weight, education level and physical activities other than dance were recorded. Body fat ratio analysis was performed with the with dual-energy X-ray absorptiometry (DEXA) (iDXA, GE Lunar, Madison, Wisconsin, USA). All the training program of the dancers was questioned in detail. The number of dance injuries diagnosed in the last year was recorded. The relationship between injury incidence and other physical parameters was examined.

Results: Forty-four dancers who met the inclusion criteria were evaluated. Thirty-five participants reported being injured at least once in the past 12 months. The most injured areas were reported as lumbar, ankle, neck, shoulder and knee. Nearly 60% of the participants reported that they train more than two hours a day. There was a statistically significant relationship between pain, fatigue, and previous injury with injury profile ($p<0.05$). No statistically significant relationship was found between the incidence of injury and running training, interest in other sports, and doing strengthening exercises ($p>0.05$).

Conclusion: While pain, fatigue, and incomplete healing of the previous injury are related with the injury profile, strengthening exercise, running and participating other sports activities do not have any impact.

Keywords: *Ballet dancers, injury profile, sports medicine*

ÖZ

Amaç: Bale dansı yapan kişilerde kas-iskelet sistemi yaralanma profilini oluşturmaktır.

Gereç ve Yöntemler: Araştırma Ege Üniversitesi, Tıp Fakültesi Spor Hekimliği Anabilim Dalı'nda gerçekleştirilmiştir. Çalışma grubuna İzmir Devlet Opera ve Balesinde görev yapan bale dansçıları dahil edilmiştir. Çalışmaya gönüllü olan bireylerin yaş, cinsiyet, boy, vücut ağırlığı, eğitim düzeyi ve dans dışındaki fiziksel aktiviteleri kaydedildi. DEXA cihazı ile vücut yağ oranı analizi yapıldı. Dansçıların tüm antrenman programı detaylı bir şekilde sorgulandı. Son bir yıl içinde tanısı konulan dans yaralanmalarının sayısı kaydedildi. Yaralanma insidansı ile diğer fiziksel parametreler arasındaki ilişki incelendi.

Bulgular: Çalışmaya 44 kişi dahil edildi. Otuz beş katılımcı, son 12 ayda en az bir kez yaralandığını bildirdi. En çok yaralanan bölgeler bel, ayak bileği, boyun, omuz ve diz olarak bildirildi. Katılımcıların yaklaşık %60'ı günde iki saatten fazla antrenman yaptıklarını bildirdi. Ağrı, yorgunluk ve önceki yaralanmalar ile yaralanma profili arasında istatistiksel olarak anlamlı ilişki bulundu ($p<0.05$). Yaralanma ile koşu antrenmanı, diğer sportif aktivite ve kuvvetlendirme egzersizi yapma arasında istatistiksel olarak anlamlı bir ilişki bulunmadı ($p>0,05$).

Sonuç: Ağrı, yorgunluk, önceki yaralanmanın tam iyileşmemesi ile yaralanma profili arasında ilişki olduğu görülmüş, kuvvetlendirme egzersizi, koşu antrenmanı ve diğer sportif aktivitelerin ise ilişkili olmadığı saptanmıştır.

Anahtar Sözcükler: *Bale dansı, yaralanma profili, spor hekimliği*

INTRODUCTION

It is estimated that there are 32,000 private dance schools and studios in the United States (US) and 3.5 million children receive dance training from dance experts (1). There is no such clear data in Türkiye. Ballet is a type of dance that requires high performance, athletic physical build, intense work, physical strength and fitness. Often, children first enrol in a ballet class before exploring other forms of dance in their careers (1). Since ballet dance requires a high training tempo, dancers have to start at a younger age compared to other branches. The starting age of ballet training is between the ages of 11-21. For girls, this age range can go down to 8-10 years (2).

Individuals performing ballet dance have been training for many years. As a result of these trainings, anatomical and physiological changes occur in the bodies of dancers (3). The figures and positions involved in ballet dance are quite different and injuries may arise due to unique mechanics (4). Ballet training includes physically demanding repetitive, rotational movements and positional works that include

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the endpoint of joint angles, and can cause injury. It is not surprising that there is concern about the incidence rate, severity, and long-term effects of injury occurring in ballet (5). Foot (34.5%), knee (27.7%) and ankle (12.7%) injuries have the highest rates in ballet dancers. These regions are followed by lumbar region (23%) and hip (17.5%) injuries (6). Early symptoms of knee, hip, and first metatarsophalangeal joint osteoarthritis were seen in professional ballet dancers aged 19-36 years, and a high prevalence of osteoarthritis was found in retired ballet dancers (7). Allen et al. found that retired professional ballet dancers had difficulty in walking due to hip or knee pain compared to non-dancers (8). This can lead to psychosocial and other problems related to daily life or sports activities. These ailments bring financial and medical burden. It has been shown that the risk of injury increases approximately five times per 1000 hours of work (1). Epidemiological studies reveal the incidence of injury as high as 42-77% (9). Overuse injuries in ballet dancers of all levels account for 65.9% of all dance injuries. Smith et al. reported that amateur and professional dancers had a total injury incidence of 1.09 per 1000 dance hours. While these injuries increase the necessary medical expenses for dancers, they also can cause significant problems such as retiring at an early age. The financial burden caused by the increased risk of chronic musculoskeletal disorders affects all components of the dance community (10). Identifying the intrinsic and extrinsic factors that cause these injuries can help healthcare professionals to prevent injuries. These injuries can have long-term consequences on the musculoskeletal system and ultimately lead to decreased physical activity levels, therefore it is important to try to prevent injuries (11). The average ballet dancer trains for at least one hour a day. During these trainings, the dancer performs many exercises to increase the balance and coordination of his/her body (12). In addition, the dancer trains to extend the limits of range of motion and body flexibility. These trainings may place extra load on the anatomical structure and can cause various musculoskeletal problems (11). If these problems are not treated, they cause muscle weakness eventually and increase injury risk, as well. The injuries may even lead to give up dancing (13).

There are few studies examining ballet injuries in Turkey. Such studies pave the way for establishing preventive programs to reduce the risk of injury. The aim of our study is to investigate the profile of injury incidence in ballet dancers.

MATERIALS and METHODS

Participants

The research was carried out in the Department of Sports Medicine at Ege University. Ballet dancers working in İzmir State Opera and Ballet were included in the study group. Those who volunteered for the study applied to Ege University Department of Sports Medicine.

The dancers who were training at least for two years included in the study. Dancers having an history of any chronic or oncological disease were excluded.

The research was approved by the Ege University Medical Research Ethics Committee. Based on similar studies in the literature(14–16), the smallest sample size was calculated as 37 with 50% frequency power analysis, with a 5% margin of error and 95% confidence interval.

Assessment

Age, gender, height, body weight and education level were recorded. Training programs of the dancers were documented in detail. These evaluations were conducted through face-to-face interviews. The number of training days per week were recorded. The average duration of each training session was recorded as less than 30 minutes; 30-60 minutes; 60-90 minutes; 90-120 minutes and more than 120 minutes. Multiple trainings in a day have been recorded, as well. The warm-up programs were classified as; whole body exercise, stationary stretches, dynamic stretches, position-specific exercises, ballet technique-specific exercises, and no warm-up. Dancers who had additional exercises such as; running and strengthening were recorded. Frequency and exercise mode were documented. The number of injuries that interfered the dancing activity in the last 12 months were recorded. The participants who were examined by a physician and had diagnosis of injury have been documented as; "I was not diagnosed" “overuse injury”, “pain”, “loading (stress) fracture”, “sprain”, “tear” and “nonspesific pain” and the injured body area has been recorded. Time of injury has been documented as; "I don't remember, “when I was dancing”, “when I was doing warm-up” or “cool-down exercise”, “when I was doing strengthening exercise”, “when I was doing another sport”, “when I was doing my daily living activity". Personal opinions of the dancers about the cause of the injury were enquired with the options; "overloading”, “inability to work in the correct position”, “fatigue”, “not being well assisted”, “unhealed previous injury”. The treatments received for these injuries were questioned in detail. Body fat ratio analysis was performed with the dual-energy X-ray absorptiometry (DEXA) (iDXA, GE Lunar, Madison, Wisconsin, USA) (17).

Statistical Analysis

Numerical data were summarized using mean, standard deviation, median, minimum and maximum values, and categorical data were summarized using frequency and ratio values with IBM SPSS Statistics 25.0 (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) package program. The level of significance in all hypotheses was determined as $p<0.05$.

The distribution of the participants' characteristics was analysed with the Pearson Chi-square test and Fisher's exact test. In logistic regression, the outcome variable was binary: with injury or no injury, and the odds ratio was estimated. Multinomial logistic regression analysis was also performed for injury groups.

RESULTS

The data of 44 ballet dancers were analysed. Table 1 and Table 2 show demographic, physical and training characteristics of the participants.

Table 1. Demographic and Physical Characteristics of Participants

Sex, n (%)	
Men	23 (52.3)
Women	21 (47.7)
Age, mean±SD, years	35.75±12.75
Height, mean±SD, cm	170.86±8.71
Weight, mean±SD, kg	61.65±15.32
Body Mass Index, mean±SD, kg/m²	21.33±1.34
Body Fat Ratio, mean±SD	11.48±2.62
Education Level, n (%)	
High school	1 (2.3)
University	29 (65.9)
Pre-university	3 (6.8)
Master Degree	11 (25.0)

N: number of individuals; SD: standard deviation; kg: kilogram; m: meter; cm: centimetre

Nearly 60% of the participants reported that they were training more than two hours a day. The rate of more than one workout per day was also found to be high. Only one participant reported that she did not make warm-up exercises. 13 ballet dancers indicated that they had running exercises. 11% of the dancers did not have any strengthening exercises. 40% of participants were training in other sports besides dancing.

Injury Incidence in Ballet Dancers

Injury history of the participants were obtained in details (Table 3). 50% of ballet dancers reported having been injured at least once in the last 12 months. About 30% of the participants reported that their injuries were associated with pain and fatigue was the most common cause of injury. 47% of injuries were occurred while dancing.

Table 2. Training Characteristics of Participants

Training time, n (%)	
<30 minute	1 (2.3)
30-60 minute	3 (6.8)
60-90 minute	6 (13.6)
90-120 minute	8 (18.2)
>120 minute	26 (59.1)
Doing more than one workout a day, n (%)	
Yes	35 (79.5)
No	9 (20.5)
Warm-up program, n (%)	
Total Body Exercise	30 (68.2)
Stretching	4 (9.1)
Position-Specific Exercises	3 (6.8)
Technique-Specific Exercises	6 (13.6)
No warm-up	1 (2.3)
Running, n (%)	
Yes	13 (29.5)
No	31 (70.5)
Running Options, n (%)	
Treadmill	7 (53.8)
Outdoor	6 (46.1)
Strengthening Exercise Frequency, n (%)	
0	5 (11.4)
1	7 (15.9)
2	15 (34.1)
3 and more	17 (38.6)
Other Sports, n (%)	
Yes	18 (40.9)
No	26 (59.1)
Other sports, n (%)	
Pilates	9 (50)
Yoga	6 (33.3)
Cycling	3 (16.6)

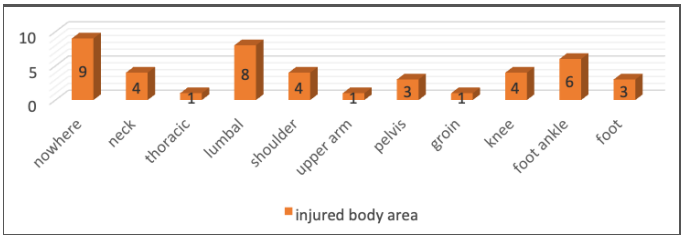
N: number of individuals

Table 3. Injury Profile of Ballet Dancers

Incidence of injury in last 12 months, n (%)	
0	9 (20.5)
1	22 (50)
2	6 (13.6)
3 and more	7 (15.9)
Injury diagnosis, n (%)	
Overuse	10 (28.5)
Inflammation and pain	13 (37.1)
Stress fracture	5 (14.2)
Strain and sprain	5 (14.2)
Tears	2 (5.7)
Injury Cause, n (%)	
Training with excess weight	10 (28.5)
Training incorrect posture	4 (11.4)
Fatigue	14 (40)
Previous injury not healing	8 (22.8)
Injury Time, n (%)	
Not remember	5 (14.2)
Dance	21 (60)
Warm-up training	1 (2.8)
Strengthening training	7 (20)
Stretching training	1 (2.8)
Doing other sports	1 (2.8)
Treatment, n (%)	
Medical treatment	13 (37.14)
Physical therapy	8 (22.85)
No treatment	14 (40)

N: number of individuals

Most of the injured ballet dancers stated that they did not receive any treatment. The lumbar spine and foot-ankle were found to be the most frequently injured areas (Graph 1). According to logistic regression analysis, no statistically significant relationship was found between the incidence of injury and running training, interest in other sports, and doing strengthening exercises (p>0.05) (Table 4).



Graph 1. Injured Body Area

Table 4. Regression Analysis of Injury Incidence with running, strength training and other sports

	Injury incidence
Running	0.647*
Other sports	0.905*
Strength Training	0.815*

* *p>0.05*

DISCUSSION

Ballet dancers are at high risk for musculoskeletal injuries due to the large number of technical movements they perform over and over again, especially in extreme ranges of motion(16) . Dance injury is defined as pain, discomfort, and pathological physical problem that occurs during dance that causes altered participation, dysfunction, decreased range of motion, or immediate cessation of dance activity (18). Because ballet dancing includes high aerobic activity, professional dancers tend to have an unhealthy body structure when combined with a wrong diet routine. The BMI of the volunteers was 21 kg/m^2 and the body fat ratio was calculated as 11% in parallel with the studies in the literature (19).

Costa et al. reported average daily training time of ballet dancers as five hours (12). Nearly 60% of the ballet dancers train more than two hours per day. Prolonged training time increase the incidence of injury. Almost 80% of the participants declared that they were training more than once a day. Fatigue related with train loads may lead to overuse injuries.

It is recommended to add a warm-up period to the training program to prevent injuries (20). 68% of the ballet dancers in our study reported that they did warm-up exercises for the whole body as recommended. Aerobic activities such as running increase aerobic endurance in dancers. 29% of the participants had running exercises in their training program. Moderate-intensity aerobic activity program at 60-80% of the maximum heart rate for 30-60 minutes per day is recommended (21). There was no significant relationship between injury and running training. Running at the appropriate intensity and duration, will increase aerobic endurance and can prevent injuries that may occur due to fatigue(22).

Toby et al. stated the lack of investigations about general injury incidence related to dancing (9). We found that approximately 80% of ballet dancers have experienced at least one musculoskeletal injury in a year, 16% of the participants had three or more musculoskeletal injuries. 47% of the injured dancers stated that these occurred while dancing.

The injured dancers reported their diagnoses as pain, stress fracture, sprain/rupture and tear. 30% of participants described their injuries as pain. The region with the highest frequency of injury varies in studies (5). In our study, the lumbar region took the first place. Forced and repetitive movements of the trunk put a strain on the musculoskeletal system of the spine. It has been reported that the rate of low back pain can reach 74% in dancers who perform professional dance for 14 years or more. Poor postural control, coordination disorder in dance technique, muscle strength imbalance, hypermobility and muscle tension, rotational movements at maximum power in the lower extremities, repetitive activities in postures that do not conform to physiology have been shown as causes of low back pain (23,24). Due to the weakness and imbalance in the muscles around the pelvis, abdomen and lumbar region, the neutral position of the pelvis cannot be maintained during movements, and in this case, an increase in lumbar lordosis is observed. Spinal joint degeneration and pain is common in dancers.

18% of the injured people thought that the cause of injury was due to overuse. Generally, these injuries are seen in the foot and ankle, knee and hip. It has been reported that dance figures with excessive rotation and repetition in ballet positions such as "attitude" and "arabesque" also contribute to injuries (25).

Stress fracture is the most common injury type in the literature (25). In our study, 11% of participants had stress fractures. Sprains and ruptures occurred in 11% and 4% of the participants, respectively. These types of injuries are most common in the foot and ankle. Ballet dancers often perform jumping and quick landing actions in their performances. Repetitive movements like rising and falling on the foot trigger stress fracture. Existing foot deformities such as pes cavus are predisposing factors for stress fractures (26).

Fatigue is a common complaint in ballet dancers. Ballet dance training includes repetitive exercises to reach

tion. Resting periods are usually insufficient for recovery. In particular, lifting the partners in ballet dancing is regarded as one the causes of injury (27). The loaded activities performed by ballet dancers were accused to lead microtraumas (28).

35% of the participants reported that they did not receive any treatments even though they were injured. Training and performing without full recovery will eventually cause re-injury (29). Moreover, this may lead to mispositioning and they cannot maintain the posture to perform dance figures (28). 9% of ballet dancers were stated that they injured due to inability of maintaining correct posture.

Only 60% of injured professional dancers stated that they sought medical treatment and/or physical therapy. While 37% of those received medical treatment, only 22% had physical therapy. In professional ballet dancing, it has been reported that physical therapy following injuries are quite insufficient in respect to high incidence of injury (29). Aerobic and muscular endurance are critical in prevention of ballet injuries (22). Since coordination and muscle balance are important, the musculoskeletal system should be well analysed (31). Physical therapy should be recommended and the dancer should not continue dancing and training before tissue healing is complete (29).

The strength of our study is the detailed investigation of the incidence of injury and risk factors. Low number of participants due to the Covid-19 pandemic is one of the limitations of this study. Secondly, the incidence of injury and related factors may be different in male and female ballet dancers, but we did not perform distinctive investigation in that respect.

CONCLUSION

Pain, fatigue, and lack of treatment for previous injury was related with ballet injuries. Strength and aerobic training are not associated with ballet injuries. There is a need of extensive investigation to define injury risks and preventive measures in ballet dancing.

Ethics Committee Approval / Etik Komite Onayı

Ege University Faculty of Medicine Clinical Research Ethics Committee (approval number:: 21-5T/9, date: 06.05.2021)

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

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