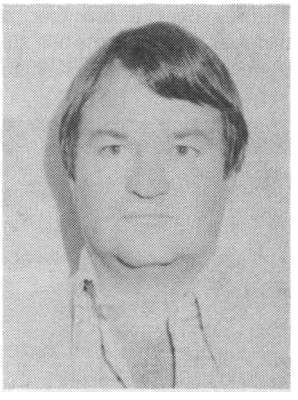
P. Klemp



I. D. Learmonth

HYPERMOBILITY AND INJURIES IN A PROFESSIONAL BALLET COMPANY

P. KLEMP, MD, FCP(SA), and I. D. LEARMONTH, FRCS, FCS(SA)

Groote Schuur Hospital, Cape Town, South Africa

ABSTRACT

A study was conducted on members of the Cape Performing Arts Board (CAPAB) professional ballet company to determine the prevalence of hypermobility and to document the injuries sustained over a ten year period. If forward flexion, which is acquired through training, is excluded as a parameter the difference in hypermobility between dancers and controls is not statistically significant. Considering the stresses imposed on the musculoskeletal system, the number of injuries was surprisingly low. Ligamentous injuries about the ankle and knee were both common and accounted for the major morbidity. There were minor differences in the nature and severity of injuries in the male and female dancers. Back injuries, fractures and osteoarthrosis were uncommon and shin splints was not recorded in any of the dancers.

Key words: Hypermobility, Ballet dancers, Injury.

INTRODUCTION

Heavy demands are made on ballet dancers. Not only must they be physically fit but muscle control is essential to enable them to master the various dance movements and to maintain postures, many of which are unanatomic (Figs. 1, 2 and 3). All injuries sustained by dancers, especially professional dancers, are a cause for concern. Not only may their careers be jeopardised by a major trauma such as rupture of the Achilles tendon (Miller et al, 1975) but even a minor injury such as a pulled muscle may impair their ability to perform for a considerable period of time. The observation that ballet dancers tend to be hypermobile (Grahame and Jenkins, 1972) is very relevant because it is well known that hypermobile individuals are prone to musculoskeletal injuries (Kirk et al, 1967; Carter and Sweetnam, 1958; Nicholas, 1970; Grahame 1971; Scott et al, 1979; Bird et al, 1978). The present study was conducted on members of a professional ballet company to analyse the

Figure 1 *Photographer Pierre Oosthuysen*

injuries over a ten-year period, and to document the number of hypermobile dancers to determine the role of hypermobility as a risk factor to injury in the dancers.

Figure 2 *Photographer Pierre Oosthuysen*

METHODS

The study was conducted at the University of Cape Town Ballet School on members of the Cape Performing Arts Board (CAPAB) professional ballet company. A mobility score for each dancer was determined using Beighton's modification of the Carter and Wilkinson method (Beighton et al, 1973) and was compared with age- and sex-matched controls which included nurses, medical students and doctors. Each subject is given a numerical score of 0-9, one point being allocated for the ability to perform each of the following tests:

1) Passive dorsiflexion of little fingers beyond 90°.
2) Passive apposition of thumbs to flexor aspects of the forearm.
3) Hyperextension of elbows beyond 10°.
4) Hyperextension of knees beyond 10°.
5) Forward flexion of the trunk with knees straight so that the palms rest flat on the floor immediately in front of the toes.

A score of 4 or more out of 9 was taken to indicate hypermobility.

Figure 3 *Photographer Montgomery Cooper*

All injuries sustained by professional dancers while dancing are reported to the Workmen's Compensation Board. Injuries are fully documented with initial, interim and final reports and include the duration of incapacity and management. The records for a ten year period were analysed and the number of years danced by the Company within that time was calculated. The injuries were classified into 3 grades of severity based on the time off duty, the severity of pain and the loss of function (Table I).

Forty-seven dancers, 30 females and 17 males, were studied. Their ages ranged from 19 to 47 years (mean 27.8); 46 were South African Caucasoid and 1 was Cape Coloured.

RESULTS

Articular mobility

The mobility scores of the dancers and controls are shown in Figure 4. A marked difference in the two groups for scores 0 and 1 is noted. Thirty-five (74.5%)

TABLE I

Classification of muscle and ligament injuries.

Grade	Time off Work	Pain	Loss of Function	Instability (ligament only)
1 (minor)	48 hours	+	o (Absent)	o (Absent)
2 (moderate)	48 hours → 14 days	++	+ → ++ (Present)	o → + (Absent or present)
3 (major)	> 14 days	+++	+++ (Marked)	+ → +++ (Present)

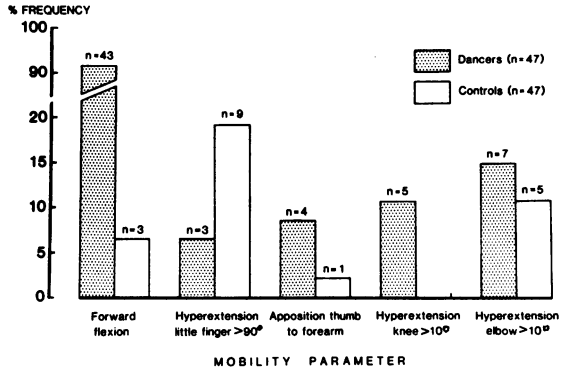


Fig. 4: Mobility scores of dancers and controls.

of the controls and only 4 (8.5%) of the dancers had a score of 0 as compared to 7 (14.9%) controls and 27 (57.5%) dancers with a score of 1. All 27 dancers, but none of the 7 controls with score 1 could do forward flexion. If forward flexion is excluded as a parameter the number of dancers with score 0 rises from 4 to 31 (65%) which is virtually identical to the number of controls with score 0. Two dancers, both female, were hypermobile with scores of 4 and 6, and also one of the controls, a nurse aged 21 who scored 5. All 3 had as one of the parameters forward flexion. If forward flexion is excluded from their scores the dancer with score 4 would no longer qualify as being hypermobile.

Figure 5 illustrates the percentage frequently distribution of the individual parameters of the two groups. The difference in the ability of the dancers to do forward flexion (43 or 91.5%) and controls (3 or 6.4%) is striking. The potential total number of manoeuvres that would be achieved on Beighton's 9 point system by each group is 423. The actual number achieved by the dancers was 76 and the controls 22. When analysed

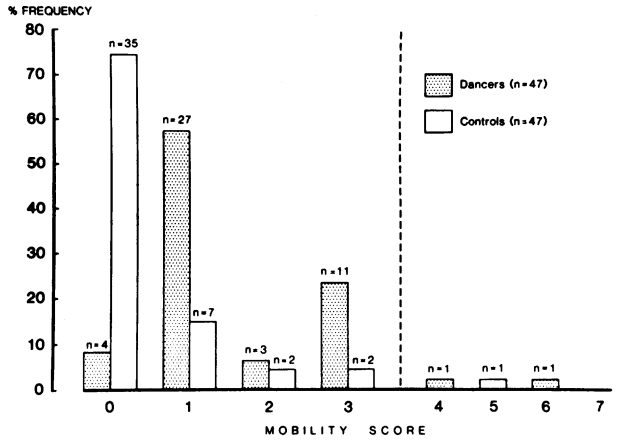


Fig. 5: Distribution of mobility parameters in dancers and controls.

using the Chi square test with Yate's correction, the difference between the two groups was highly significant ($p < 0.001$). If forward flexion is excluded as a parameter the potential number of manoeuvres that could be achieved by each group is 376. The actual number achieved was 33 and 19 for the dancers and controls respectively. This difference was not significant. Applying the Chi square test to each of the four pairs of manoeuvres (hyperextension of knees, elbows, etc.) there was no significant difference in any of the manoeuvres between the two groups without correcting for multiple testing (Miller, 1981). Therefore forward flexion is the parameter which accounts for the increased overall mobility in ballet dancers.

In ten years of dancing the dancer with mobility score 6 had eight injuries, four of which were severe, and the dancer with score 4 had one minor injury. There was no difference in the number or nature of the injuries sustained by these dancers compared with 10 dancers of similar age and dancing experience who were not hypermobile. The number of hypermobile dancers in the study, however, is too small for statistical evaluation. Hyperextension of the little finger beyond 90° was present in three of the dancers, one of whom was the dancer with score 6, and in nine of the controls which included the nurse with score 5. The four dancers with score 0 were males. None of the males in either group scored more than 2.

Injuries

The injuries in the 10 year period of analysis occurred in a total of 260.15 dance years (mean 5.5 per dancer). Soft tissue injuries involving ligaments and muscles were encountered most frequently (Tables II and III). Considering the physical stresses endured by a ballet dancer, it is not surprising that most of the ligament injuries occurred about the ankle, followed by the knee. Of 35

TABLE II

Ligament injuries.

Upper Limb/Trunk

Site	Mild	Moderate	Severe	Total
Neck	2			2
Shoulder	2	1		3
Thumb	1		1	2
Proximal inter-phalangeal joint	1			1
Lumbar spine	3	2	1	6
Total	9	3	2	14

Lower Limb

Site	Mild	Moderate	Severe	Total	
Knee	7	2	5	14	
Ankle					
Lateral ligament	6	6	3	15	
Medial ligament		1	1	2	35
Anterior capsule	2	2	1	5	
Unspecified	8	4	1	13	
Midtarsal sprain	1	1	3	5	
Hallux	2			2	
Toes		1		1	
Total	26	17	14	57	

TABLE III

Muscle injuries.

Trunk

Site	Mild	Moderate	Severe	Total
Intercostal	1	1		2
Rectus abdominus	1			1
Back	5	2		7
Total	7	3	0	10

Lower Limb

Site	Mild	Moderate	Severe	Total
Hip				
Adductor		2	3	5
Flexors	1	1		2
Quadriceps	1	1	3	5
Hamstrings	2	2		4
Soleus			1	1
Gastrocnemius	6	4		10
Calf (unspecified)	3	2		5
Extensor digitorum brevis		1		1
Total	13	13	7	33

ligament injuries at the ankle, six were serious, three of which required surgery (all lateral ligament). Five of 14 knee ligament injuries were serious, all of which required surgery. There were two isolated ruptures of the anterior cruciate ligament, a combined rupture of the anterior cruciate and medial collateral ligaments and a meniscal tear. Of the muscle injuries, those of the calf and thigh accounted for most of the morbidity. Although common, injury to the calf muscles did not result in serious disability, while three cases of quadriceps strain were severe as were three cases of adductor strain.

Tendon injuries were virtually indistinguishable from tendonitis and have therefore been included in Table IV which shows the number of tendon injuries, tendonitis and bursitis. Predictably, the Achilles tendon was most frequently involved and produced the greatest disability. Of the eight severe tendo-Achilles injuries, three were complete ruptures (bilateral in 1 dancer) which required surgical repair. These two dancers never returned to fully active dancing. The two cases of chronic hallux metatarsophalangeal bursitis both came to surgical excision.

TABLE IV

Bursitis/Tendonitis

Site	Mild	Moderate	Severe	Total
Hip	4			4
Knee	2	1		3
Achilles tendon	4	2	8	14
Tibialis posterior	3	1		4
Peroneus longus	1			1
Hallux bursitis			2	2
Extensor hallucis longus	1	1		2
Flexor digitorum longus	2	1	1	4
Total	17	6	11	34

Miscellaneous musculoskeletal conditions, considered to be related to dancing activities, are shown in Table V. There were five fractures of the 5th metatarsal (three of the base, one of the shaft and one of the neck). In addition, there was a fracture of the 3rd metatarsal and one of the cuneiform. Two stress fractures of the proximal tibia in the same dancer caused considerable disability and one of these required a bone graft. There were two cases of osteoarthrosis of the knee and one of the ankle.

Injuries occurring in male and female dancers were compared. A conversion factor was used to correct the disparity both in the number of dancers in each group and in the total number of years danced. It was found that the male dancer sustained a greater number of

TABLE V

Miscellaneous

Condition	Mild	Moderate	Severe
Chondromalacia patellae	1		
Traumatised plica		1	
Contusion ankle	1		
Contusion forefoot	1		
Osgood Schlatter	1		
Injury to 1st and 2nd metatarsals	1		
Injury to lateral meniscus		1	
Chipped tooth	1		

interphalangeal joint hyperextension injuries in the hand, probably related to catching. The only other differences of significance were that the male sustained twice the number of grade 2 ligament injuries as the female, while the latter sustained twice the number of grade 2 muscle injuries.

DISCUSSION

Our data do not support the view that ballet dancers are hypermobile (Grahame and Jenkins, 1972). Firstly, there was no significant difference in the number of dancers and controls who scored 4 or more. Secondly, while it is true that the total score of the mobility manoeuvres achieved by the dancers was significantly greater than controls, the difference was clearly due to the influence of forward flexion, a manoeuvre which in the dancers can be attributed to training and not of genetic origin. This is supported by the fact that with true hypermobility a period of "warming-up" is not necessary to demonstrate hypermobility in a joint, whereas most of the dancers, in order to do forward flexion with ease, need to warm up briefly beforehand. Hypermobility of other joints such as hyperextension of the knees, which would tend to cause unattractive postures and difficulties with pointe work, are not acquired through training and are genetically determined. The study provides further confirmation that females are more mobile than males (Kirk et al, 1967; Forrest et al, 1980). Hypermobility of the little finger is said to correlate well with generalised hypermobility (Beighton et al, 1973), but only two of the twelve subjects in our study with hyperextension of the little finger were hypermobile.

One of the objects of the study was to determine whether there was a difference in the number and nature of injuries sustained by hypermobile dancers. Since there were only two hypermobile dancers in the Company a comparison between hypermobile and "non-hypermobile" was not possible.

Soft tissue injuries encountered in ballet dancers require a distinct classification because many injuries that would be considered trivial in a trauma unit may cause the dancer significant professional disability. Predictably the lower limb accounted for the majority of soft tissue injuries, which were generally more severe than those encountered in the upper limb and trunk. Ligament and tendon injury which occurred most frequently at the ankles and knees were responsible for most of the serious injuries. All four of the serious knee injuries came to surgery, while only one of the serious ankle injuries, a lateral ligament rupture, required surgical repair.

It is noteworthy that the principal ballerina who ruptured the anterior cruciate and medial collateral ligaments of the right knee was able to resume active dancing after surgery. The observation that the rupture of the Achilles tendon is a most disabling injury and usually prevents return to active dancing despite surgical repair (Miller et al, 1975) is borne out in our study.

The number of back injuries was surprisingly small and occurred with equal frequency in male and female dancers. The differences in injury patterns encountered in males and females are regarded as minor and of no practical relevance. Considering that this review represents 260 years of professional dancing, the total number of injuries recorded are remarkably few. This must be attributed to the great physical fitness and discipline of the dancer.

While fractures were rare, the 5th metatarsal was noted to be particularly at risk and accounted for over 50% of all fractures encountered. Stress fractures of the tibia in ballet dancers are well described (Schneider et al, 1974; Miller et al, 1975; Saunders et al, 1979; Grahame et al, 1979). In our study this occurred in only one dancer in whom it was bilateral and required bone grafting on 1 side. Shin splints, commonly reported in other reviews (Washington 1978; Miller et al, 1975) was notably absent in our study. The most likely explanation is that all the studios at the ballet school and most of the theatres in Cape Town where performances are held have sprung floors. It is only when the Company is on tour, where performances are usually given on rigid floors, that shin splints occasionally develop.

ACKNOWLEDGEMENTS

We would like to thank Mr. Sedick Isaacs for his help with the statistical evaluation; also Professor David Poole, Artistic Adviser to the CAPAB Ballet Company and Director of the University of Cape Town Ballet School, and Mrs. Janet Le Sueur, Manager of the CAPAB Ballet Company, for permission to conduct the study.

REFERENCES

Beighton, P., Solomon, L. and Soskolne, C. L., 1973 "Articular mobility in an African population". Ann.rheum.Dis. 32: 413-418.

Bird, H. A., Tribe, C. R. and Bacon, P. A., 1978 "Joint hypermobility leading to osteoarthrosis and chondrocalcinosis". Ann.rheum.Dis. 37: 203-211.

Carter, C. and Sweetnam, R., 1958 "Familial joint laxity and recurrent dislocation of the patella". J.Bone Jt.Surg. 40B: 664-667.

Forrest Jessee, E., Owen, D. S. and Sagar, K. M., 1980 "The benign hympermobile joint syndrome". Arth.Rheum. 23: 1053-1056.

Grahame, R., 1971 "Joint hypermobility – clinical aspects". Proc.Roy.Soc.Med. 64: 692-694.

Grahame, R. and Jenkins, J. M., 1972 "Joint hypermobility – asset or liability?" Ann.rheum.Dis. 31: 109-111.

Grahame, R., Saunders, A. S. and Maisey, M. N., 1979 "The use of scintigraphy in the diagnosis and management of traumatic foot lesions". Rheumatol.Rehabil. 18: 235-238.

Kirk, J. A., Ansell, B. M. and Bywaters, E. G. L., 1967 "The hypermobility syndrome". Ann.rheum.Dis. 26: 419-425.

Miller, E. H., Schneider, H. J., Bronson, J. L. and McLain, D., 1975 "A new consideration in athletic injuries. The classical ballet dancer". Clin.Orthop. 111: 181-191.

Miller, R. G., 1981. Simultaneous statistical information. Springer-Verlag, New York.

Nicholas, J. A., 1970 "Injuries to knee ligaments". JAMA 212: 2236-2239.

Saunders, A. J. S., El Sayed, T. F., Hilson, A. J. W., Maisey, M. N. and Grahame, R., 1979 "Stress lesions of the lower leg and foot". Clin.Radiol. 30: 649-651.

Schneider, H. S., King, A. Y., Bronson, J. L. and Miller, S. N., 1974 "Stress injuries and developmental change of lower limb extremities in ballet dancers". Radiology 113: 627-632.

Scott, D., Bird, H. and Wright, V., 1979 "Joint laxity leading to osteoarthrosis". Rheumatol.Rehabil. 18: 167-169.

Washington, E. L., 1978 "Musculoskeletal injuries in theatrical dancers. Site, frequency and severity". Am.J.Sports Med. 6: 75-98.

OBITUARY

Dr. Mohamed Kamal Kheir-Eldin, MB, BCh

Dr. Kheir-Eldin qualified in Egypt in 1960, and moved to the UK nearly twenty years later, being admitted to the UK Medical Register in 1980. He was in general practice in Barking, where he included many injured athletes among his patients. He joined the BASM in 1981, and was a keen supporter of our meetings. He had an interest in the biomechanics of sporting performance, as well as in related psychology and physiology.

H. E. Robson