

# Injuries in a Modern Dance Company

## Effect of Comprehensive Management on Injury Incidence and Time Loss

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**Background:** Professional dancers experience high rates of musculoskeletal injuries.

**Objective:** To analyze the effect of comprehensive management (case management and intervention) on injury incidence, time loss, and patterns of musculoskeletal injury in a modern dance organization.

**Study Design:** Retrospective/prospective cohort study.

**Methods:** Injury data were analyzed over a 5-year period, 2 years without intervention and 3 years with intervention, in a modern dance organization (42 dancers). The number of workers' compensation cases and number of dance days missed because of injury were compared across a 5-year period in a factorial design.

**Results:** Comprehensive management significantly reduced the annual number of new workers' compensation cases from a high of 81% to a low of 17% and decreased the number of days lost from work by 60%. The majority of new injuries occurred in younger dancers before the implementation of this program. Most injuries involved overuse of the lower extremity, similar to patterns reported in ballet companies. Benefits of comprehensive management included early and effective management of overuse problems before they became serious injuries and triage to prevent overutilization of medical services.

**Conclusions:** This comprehensive management program effectively decreased the incidence of new cases and lost time. Both dancers and management strongly support its continuance.

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Dance is a "high-risk" activity with a well-documented high incidence of musculoskeletal injuries. Annual injury rates at classical ballet companies average from 67% to 95%.<sup>1,6,15,20</sup> Overuse injuries account for the majority (60% to 76%) of all dance injuries.<sup>15,18,20</sup> Some dancers appear to be at higher risk of injury than others. At one ballet company, one group of dancers averaged 6.7 injuries each, versus an average of 1.86 injuries in the remaining injured dancers.<sup>6</sup>

Many ballet companies in the United States have instituted in-house medical and therapy services to reduce the physical and financial impact of injuries on the dancer and company. In one ballet company of 70 dancers, this resulted in a decrease of annual injuries from 94% to 75%

and savings in excess of \$1.2 million over a 5-year period.<sup>20</sup>

Modern dance has had a major influence on dance in America. However, modern dance companies tend to have fewer dancers and smaller budgets than ballet companies. High injury rates in smaller companies put a greater strain on dancers, who must cover for injured company members. These injury-related costs, in turn, strain the finances of companies with smaller budgets. Based on the positive results from in-house medical and therapy services at several ballet companies,<sup>1,6,20</sup> a comprehensive management program was established at a professional New York City modern dance organization, Alvin Ailey.

The objective of this research was to assess the effect of comprehensive management (on-site case management and intervention) on injury incidence, time loss, and patterns of musculoskeletal injury in a professional modern dance organization. Comparisons were made between a 3-year intervention period (years 3, 4, and 5: 1998 to 2001) and the 2-year period before the intervention program (years 1 and 2: 1996 to 1998).

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TABLE 1  
Demographic Data for the Dancers in the Study

Company	Age (years)	Sex	Company seniority (years)
1st Company	27 ± 4.4 (range, 19–40)	15F/15M	5.0 ± 3.1 (range, 0–19)
Senior members	31 ± 5.6	7F	8.0 ± 5.4
Junior members	27 ± 3.0	7M	6.0 ± 1.4
	25 ± 2.2	8F	1.0 ± 1.1
	25 ± 2.8	8M	2.0 ± 1.1
2nd Company	22 ± 1.7 (range, 19–26)	6F/6M	1.0 ± 0.5 (range, 0–3)

## MATERIALS AND METHODS

### Subjects

The subjects of this study were the dancers in the two companies of Alvin Ailey. The senior company, Alvin Ailey American Dance Theater (1st Company), comprised 30 dancers, and the junior company, Ailey 2 (2nd Company), comprised 12 dancers. Data from the 42 dancers of the two companies were included in this analysis. Any dancer performing less than 30 days annually was not included. (One 60-year-old dancer performs only several times during the season. This dancer was not included, and he did not sustain any injuries.) The 30-member 1st Company included 15 male and 15 female dancers, and the 2nd Company included 6 male and 6 female dancers. Demographic data over the 5-year period are shown in Table 1. The 2nd Company serves primarily as a training company; dancers in this company are younger and stay in this company for approximately 2 years, after which they either move into the 1st Company or on to other dance opportunities. The total number of dancers and the male-to-female ratio remained the same across the 5-year period. There was an average annual turnover rate of six dancers.

Designing a comprehensive management program was challenging because the 1st Company spends a large por-

tion of their time touring. The 1st Company annual contract averaged 41 ± 2.6 weeks, with 27 ± 2.9 weeks spent in national and international touring (Table 2). The 1st Company danced an average of 49,320 ± 3071 hours annually, which included 180 ± 19 performances. The 2nd Company contract averaged 35 ± 0.8 weeks, with dancers touring an average of 18 ± 2.9 weeks in smaller United States cities and venues. The 2nd Company danced an average of 16,869 ± 402 hours annually, which included 58 ± 9 performances. Rehearsal periods, during which new ballets were choreographed or repertoire was reconstructed, lasted an average of 10 ± 0.5 and 12 ± 0.5 weeks for the 1st and 2nd Companies, respectively. The number of hours danced per year, or “dance exposure,” was based on a 40-hour week multiplied by the number of contract weeks, times the number of dancers. During the touring weeks, a 40-hour week of dancing may include company class, rehearsal, lecture-demonstrations, and one to two performances daily.

### Experimental Protocol

*Injury* was defined as any musculoskeletal complaint resulting in financial outlay. This included injuries involving new workers' compensation cases as well as injuries costing less than \$500 (self-insured cases). A time-based definition of injury severity was used, with *minor* injuries causing less than 1 week of absence from dance, *moderate* injuries causing time loss of 1 to 4 weeks, and *severe* injuries causing time loss of more than 4 weeks.<sup>10</sup> Injury type was defined as either overuse or trauma. *Overuse* injury was defined as injury resulting from repetitive microtrauma and *trauma* injury was defined as resulting from a specific macrotraumatic event.<sup>21</sup>

During the 2-year period preceding intervention (years 1 and 2), no case management or regular on-site medical services were available. If a dancer believed an injury required medical attention, he or she went to an emergency department or to the company orthopaedic surgeon. The company orthopaedic surgeon referred dancers need-

TABLE 2  
Annual Dance Exposure for All Dancers and for Each Company

Year	Company	Number of dancers	Contract weeks	Performances	Rehearsal weeks	Hours of exposure per year <sup>a</sup>
1	Total	42				67,080
	1st	30	41.5	201	10	49,800
	2nd	12	36	51	12	17,280
2	Total	42				70,800
	1st	30	45	200	10	54,000
	2nd	12	35	48	12	16,800
3	Total	42				65,280
	1st	30	40	166	10	48,000
	2nd	12	36	69	12	17,280
4	Total	42				66,000
	1st	30	41	160	10	49,200
	2nd	12	35	60	13	16,800
5	Total	42				61,920
	1st	30	38	175	9	45,600
	2nd	12	34	60	13	16,320

<sup>a</sup> Hours of dance exposure per year = (40 hours/week) × (number of contract weeks) × (number of dancers).

ing physical therapy to a dance medicine specialist at a private physical therapy practice for treatment. During this period, some preventive physical therapy services were established for the 1st Company. This included coverage during the New York City season and backstage during the US tour. However, no coordinated comprehensive management services existed, nor was any intervention established for the 2nd Company.

Following the example of Solomon and colleagues,<sup>19,20</sup> we designed a comprehensive management program (years 3 to 5), including intervention and case management services, for the dancers of the two companies. A "self-insurance policy" was instituted by the organization for injuries that required only one physician visit and medical bills totaling less than \$500.<sup>19,20</sup> Intervention consisted of *primary prevention* (minimizing injury risk via dance-specific annual screenings, technique modification, cross-training, and treatment of minor complaints) and *secondary prevention* (triage to determine the need for medical referral, treatment, and rehabilitation after injury).<sup>7,17</sup>

Daily on-site physical therapy intervention services were provided during rehearsal periods and backstage before all performances. Medical coverage during performances was provided by either physical therapists or physicians. On-call and case management services were provided by one part-time physical therapist. A second physical therapist accompanied the 1st Company when they were not in New York City. Funding restrictions prevented sending a physical therapist to accompany the 2nd Company during touring. However, local volunteer physical therapy coverage for the 2nd Company was arranged at as many venues as possible.

Case management services included 1) monitoring any musculoskeletal problem filed on an injury report for a dancer who did not require medical referral; 2) determin-

ing whether a medically referred injury was categorized as self-insured or as a workers' compensation claim by communication with the physician; 3) acting as a liaison with the workers' compensation insurance company to facilitate timely medical approvals for tests, surgery, and other procedures; 4) facilitating use of restricted duty days; 5) acting as a liaison between company management and dancers regarding injury status; and 6) tracking and analyzing injury data. Data tracking included date of injury, diagnosis, number of lost days, and how the injury was addressed (medical referral, self-insured or workers' compensation case, and medical costs). Restricted duty days allowed the dancer to continue to observe rehearsals or begin participation in a protected manner (for example, wearing sneakers, "marking" the movement at the back of the studio, or other means).

Guidelines were developed by a team representing the company administration, artistic staff, dancers, and medical staff. All members of the organization were informed about the program at annual orientation meetings. Injury reporting protocol included the following procedures. The dancer completed an injury report, which included information on the venue, choreography, and activity (technique class, rehearsal, or performance). For all injuries reported by dancers, triage was performed by the on-call physical therapist or physician to determine the need for further medical referral. If a dancer needed medical referral, it was determined on seeing the physician whether the injury would require more than one medical visit or entail medical expenses greater than \$500.<sup>19,20</sup>

#### Data Analysis

Comparisons were made between the 3-year comprehensive management period (years 3, 4, and 5) and the 2-year period before the intervention program (years 1 and 2).

TABLE 3  
Annual Injury Incidence and Lost Days

Year	Company	Number of injured dancers	Total number of injuries (incidence, %)	WC <sup>a</sup> injuries (incidence, %)	WC injuries/injured dancer	Lost days due to WC injuries	Total injuries/1000 hours <sup>b</sup>
1	Total	26	34 (81)	34 (81)	1.31	230 <sup>c</sup>	0.51
	1st	15	19 (45)	19 (45) <sup>d</sup>	1.27	70	0.38
	2nd	11	15 (36)	15 (36) <sup>d</sup>	1.36	160 <sup>c</sup>	0.87
2	Total	24	34 (81)	34 (81)	1.42	135 <sup>c,d</sup>	0.48
	1st	16	22 (52)	22 (52)	1.38	135	0.41
	2nd	8	12 (29)	12 (29)	1.50	<sup>c</sup>	0.71
3	Total	23	37 (88)	33 (79)	1.43	70 <sup>d</sup>	0.57
	1st	15	24 (57)	21 (50)	1.40	45	0.50
	2nd	8	13 (31)	12 (29)	1.50	25	0.75
4	Total	8	19 (45)	10 (24) <sup>e</sup>	1.25	58 <sup>d</sup>	0.29
	1st	6	13 (31)	7 (17)	1.17	47	0.26
	2nd	2	6 (14)	3 (7)	1.50	11	0.36
5	Total	7	11 (26)	7 (17) <sup>e</sup>	1.00	87	0.18
	1st	5	6 (14)	5 (12)	1.00	87	0.13
	2nd	2	5 (12)	2 (5)	1.00	0	0.31

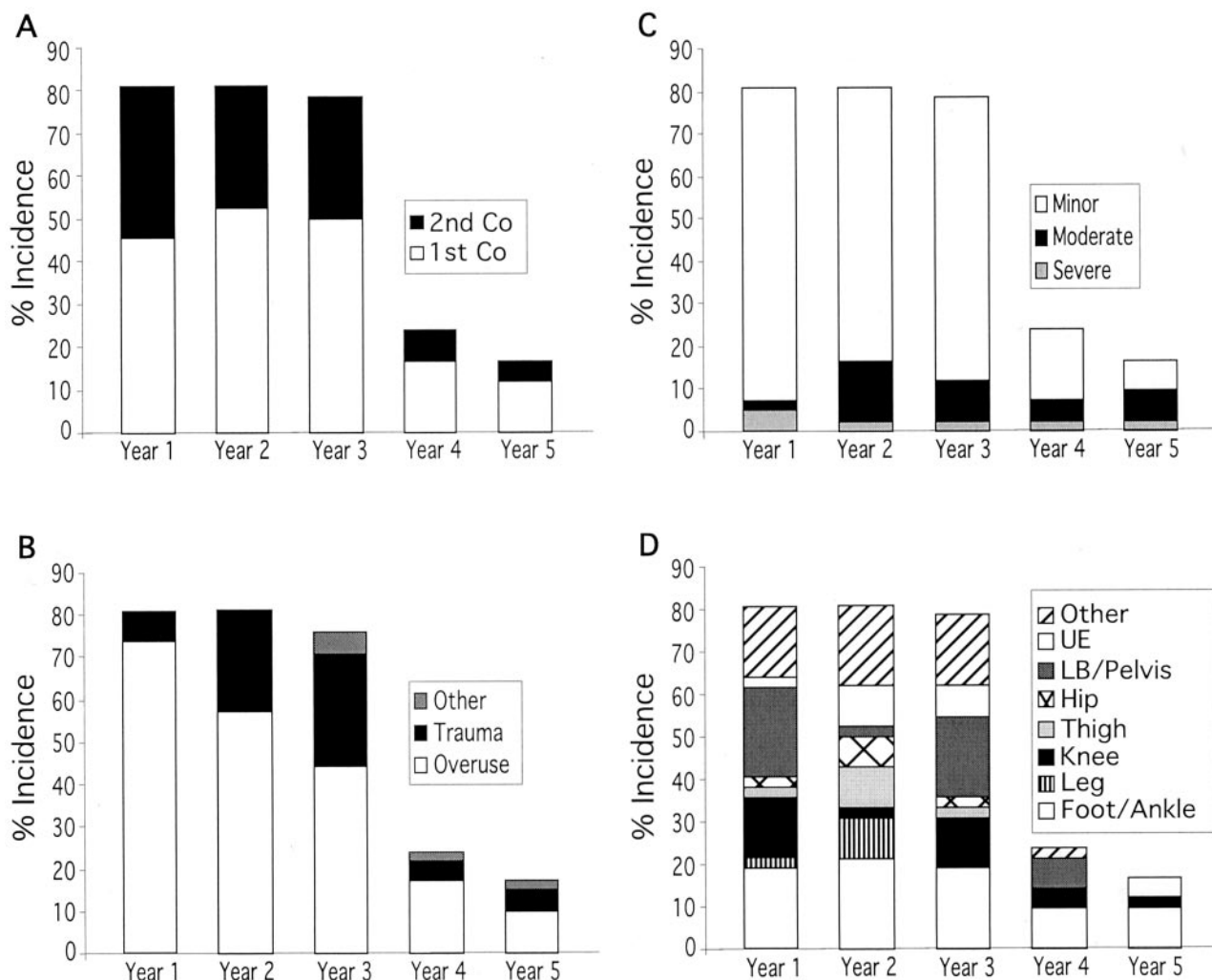
<sup>a</sup> Workers' compensation.

<sup>b</sup> Total injuries/1000 hours = 1000 × (number of self-insured + number of workers' compensation injuries)/(total hours of dance exposure).

<sup>c</sup> Some data missing or unknown.

<sup>d</sup>  $P < 0.05$ .

<sup>e</sup>  $P < 0.01$ .



**Figure 1.** Workers' compensation injuries over 5 years. A, incidence (%) of workers' compensation injuries of 1st and 2nd Companies; B, incidence (%) of overuse and traumatic workers' compensation injuries. Other injuries included nonmusculoskeletal injuries such as dehydration and superficial lacerations. C, incidence (%) of workers' compensation injuries by time-based severity classification; D, incidence (%) of workers' compensation injuries by anatomic region. Note: "other" includes head; medical, such as hyperthermia; and unknown where diagnosis was not clear. There were no cervicothoracic injuries. UE, upper extremity; LB, lower back.

Data from years 1 and 2 were compiled retrospectively from the controller, the stage manager, and workers' compensation files. Data from years 3, 4, and 5 were collected prospectively from the controller, physical therapist, stage manager, and workers' compensation files. Only injuries that resulted in financial outlay were included in tabulations. All epidemiologic research was conducted with the approval of and consistent with the policies of the Institutional Review Board at Long Island University.

The incidence of total new injuries (workers' compensation cases and self-insured cases) and new workers' compensation cases for each year was calculated by dividing the number of new injury claims by the total number of dancers for each year. The numbers of lost days (self-insured and workers' compensation cases) and injury patterns in relation to body region, injury type, injury sever-

ity, and activity (rehearsal and performance) were analyzed for each of the companies. In addition, utilization of preventive physical therapy was reviewed. Consistent information on whether the injury occurred during performance or rehearsal, and whether preventive physical therapy was utilized was not available for years 1 and 2. To compare the incidence of new injuries to injury incidence in other sports, we calculated the *incidence rate per 1000 hours of exposure* as 1000 hours times the number of new injuries divided by the total hours of dance exposure.

The number of new workers' compensation cases and number of dance days missed because of workers' compensation injury were compared across the 5 years in a multivariate analysis of variance design with two between-factors, group (1st and 2nd Companies) and sex (male and female), and one within-factor, year (years 1 to 5). Differ-

ences were considered statistically significant at the  $P < 0.05$  level. Post hoc Bonferroni comparisons were conducted where appropriate.

## RESULTS

Over the 5-year period reviewed, there were no career-ending injuries. Every injured dancer returned to work with the company. Comprehensive management reduced the incidence of new injuries and severity of injuries. The number of lost days and new workers' compensation injuries were also reduced.

### Incidence of New Injuries

The incidence of new workers' compensation cases was 79% to 81% in years 1 through 3 (2 years before intervention and 1st year of intervention) (Table 3). The incidence of new workers' compensation cases dropped to 24% and 17% in years 4 and 5, respectively. The comprehensive management program significantly reduced the number of new workers' compensation cases (combined 1st and 2nd Companies) in years 4 and 5 compared with years 1, 2, and 3 ( $F[4,35] = 9.52, P < 0.01$ ; post hoc years 4 and 5 versus years 1, 2, and 3,  $P < 0.01$ ).

The 2nd Company, with 12 dancers, accounted for a greater proportion of new workers' compensation cases in years 1, 2, and 3 compared with the 1st Company (Fig. 1A). The 2nd Company accounted for 29% of the dancers but sustained 44%, 35%, and 36% of the new workers' compensation injuries in years 1, 2, and 3, respectively. The disproportionate incidence rate of new workers' compensation injuries was significant for the 2nd Company compared with the 1st Company in year 1 ( $t = 209, P < 0.05$ ), but there were no differences in other years (Table 3). There were no differences in injury incidence for men and women. The average number of injuries per injured dancer decreased from a high of 1.4 in year 3 to a low of 1.0 in year 5. The 2nd Company accounted for a higher average number of injuries per injured dancer (1.4 to 1.5) compared with the 1st Company (1.1 to 1.4) in years 1 through 4.

In addition to new workers' compensation injuries, there were injuries covered by the self-insurance plans (these patients required a one-time medical referral or were treated for less than \$500). Total injuries (combined new workers' compensation cases and self-insured cases) are shown in Table 3. Injuries in the self-insured cases typically involved patients who, after triage, needed an orthopaedic consultation to rule out serious injury such as a fracture. The numbers of self-insured cases were four, nine, and four in years 3, 4, and 5, respectively. These injuries resulted in anywhere from 0 days absence from dance to 3 days to optimize healing and recovery. Total company self-insurance costs were less than \$2100 annually.

Total injuries per 1000 hours of dance exposure, including both workers' compensation and self-insured cases, ranged from a high of 0.51, 0.48, and 0.57 in years 1, 2, and 3, respectively, to a low of 0.29 and 0.18 in years 4 and 5,

respectively (Table 3). Injuries per 1000 hours of dance exposure in the 2nd Company exceeded those in the 1st Company during all 5 years, but were reduced with comprehensive management by 58% in years 4 and 5.

### Lost Work Days

The total number of lost work days caused by new workers' compensation injuries decreased from a high of 230 in year 1 to a low of 58 in year 4 (Table 3). The average number of lost days decreased by 60% when the average for years 1 and 2 was compared with that of years 3, 4, and 5. There was a significant difference in the number of lost days between years 2 and 3 and between years 3 and 4 ( $P < 0.05$ ). The longest period of lost days (160) for one company included lost days for a dancer with a torn ACL in year 1.

### Injury Patterns

Most injuries were microtraumatic or *overuse* in nature, encompassing minor sprains and strains (grades 1 and 2) (Fig. 1B). Included in this category were metatarsal stress fractures and osteochondritis dissecans of the ankle. The combined (1st and 2nd Companies) incidence of overuse injuries ranged from a high of 74% of the total injuries in year 1 to a low of 10% in year 5. There was also a trend toward a decreased number of *trauma* injuries seen in years 4 and 5 (5%) (Fig. 1B). Trauma injuries involved major ligament sprains and fractures.

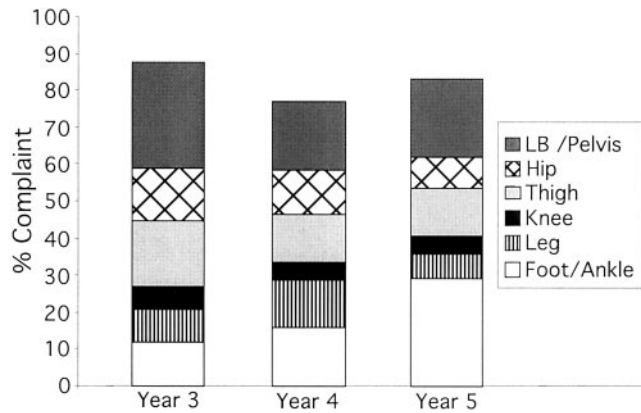
When examining the severity of injuries by using a time-based definition, we found that most of the new workers' compensation injuries were *minor*, involving less than 1 week of lost time (Fig. 1C). The incidence of minor injuries diminished over time from 74% in year 1 to 7% in year 5. *Moderate* injuries (causing more than 1 week but less than 1 month of lost time) fluctuated, with no recognizable pattern, ranging from 2% to 14% of new injuries. *Severe* injuries (causing more than 1 month of lost time) remained relatively constant, at 2% to 5%.

The majority of new workers' compensation injuries involved the lower extremity (mean, 58%; range, 45% to 71%) (Fig. 1D). Most of the lower extremity injuries involved the foot and ankle (34%; range, 24% to 57%). Lower back and pelvic injuries accounted for an average 17% (range, 0% to 30%) of the injuries.

Use of preventive physical therapy consistently increased (54%) over the 3-year comprehensive management period, from 1100 visits in year 3 to 1700 visits in year 5. All visits were for minor complaints that involved no injury report or lost time. The majority of visits were for the lower extremity (mean, 60%; range, 58% to 61%) (Fig. 2). The foot-ankle region accounted for a mean of 19% of visits (range, 12% to 29%), and the lower back and pelvic region for a mean of 23% of visits (range, 19% to 29%).

## DISCUSSION

Comprehensive management services at this modern dance organization resulted in more timely and appropri-



**Figure 2.** Visits to preventive physical therapy for problems in the lower back (LB) and pelvis or lower extremity regions over the 3-year intervention period.

ate medical referrals, decreased the number of new workers' compensation cases, and decreased the number of days missed because of injury. Establishment of this program resulted in change to a more beneficial workers' compensation carrier and contract and eliminated unnecessary medical visits, thereby decreasing injury-related costs.

### Injury Incidence and Time Loss

The incidence of new workers' compensation cases decreased from a high of 81% to a low of 17% (Table 3). The number of injuries per injured dancer decreased from 1.5 to 1.0. These numbers are lower than those reported in studies of several ballet companies with intervention programs; reported numbers range from 2.97<sup>6</sup> to 2.16.<sup>20</sup> Injury incidence, both before and after establishment of this comprehensive management program, was generally lower than the reported injury incidence of the Boston Ballet Company (94% to 77%)<sup>20</sup> (Table 4). However, Solomon et al.<sup>20</sup> stated that an average 12% of the reported injuries (determined by self-reporting) did not lead to expenditure, possibly inflating their overall injury incidence. Anderson,<sup>1</sup> in a report involving the Sacramento Ballet Company, reported an annual incidence of 67% to 100% new workers' compensation cases in the 2 years before an intervention program was begun. The incidence of new workers' compensation cases decreased to 29% and then to 0% (no new workers' compensation cases) in 2 years of intervention. One explanation for the large difference in injury rates in the Boston and Sacramento companies is that the Sacramento Ballet is a smaller company, dancing in only 40 performances per year, and hence has less exposure time. This underscores the need to consider the

**TABLE 4**  
Comparison of Injury Data from a Modern Dance Company with Data from Previous Studies on Ballet Companies

Variable	Bronner et al.	Solomon et al. <sup>20</sup>	Garrick and Requa <sup>6</sup>	Anderson <sup>1</sup>	Nilsson et al. <sup>15</sup>
Determination of injury	Medical	Self-report	Medical	Medical	Medical
Definition of injury	Financial		Financial	WC <sup>a</sup>	Orthopaedic consultation
Injury program	Comp <sup>b</sup>	Comp	Comp	Comp	
Style of dance	Modern	Ballet	Ballet	Ballet	Ballet
Number of dancers	30 (1st) 12 (2nd)	60	70+ 12 apprentices	24	78
Weeks/year	41 (1st) <sup>c</sup> 35 (2nd) <sup>c</sup>	40 <sup>d</sup>	44 <sup>d</sup>	36	
Performances/year	180 (1st) <sup>c</sup> 58 (2nd) <sup>c</sup>	131 <sup>c</sup>		40	
Injuries/injured dancer	1.0–1.25 <sup>e</sup>	2.16 <sup>c</sup>	2.97	0 <sup>f</sup>	3.8
Injury incidence	17%–24% <sup>e</sup>	94%–77%		29%–0 <sup>f</sup>	95%
Injuries/1000 hours <sup>g</sup>	0.57–0.18 <sup>h</sup>				0.62
Incidence of overuse injuries	76%–10%	60%–65%			62%
Incidence of lower extremity injury	58% <sup>c</sup>	68.5%	57%		75%
Incidence of foot/ankle injury	34% <sup>c</sup>	38%	37%		54%
Incidence of lower back/pelvis injury	17% <sup>c</sup>	12%	23%		18%

<sup>a</sup> Workers' compensation.

<sup>b</sup> Comprehensive management.

<sup>c</sup> Mean of years 1 through 5.

<sup>d</sup> Estimated number of contract weeks from data provided.

<sup>e</sup> Range of years 4 and 5.

<sup>f</sup> No injuries.

<sup>g</sup> Injuries/1000 hours = 1000 × (number of injuries)/(total hours of dance exposure).

<sup>h</sup> Range of years 1 through 5.

degree of participation exposure and its effect on injury rates.

In our study, the workload for the 1st Company (in terms of length of contract) appears comparable with that reported in studies of several other ballet companies (Table 4). However, the greater number of performances and smaller size of the 1st Company in our study, as compared with the Boston<sup>20</sup> and San Francisco<sup>6</sup> ballet companies, required that the majority of performances be danced by all of the 1st Company dancers. Exposure time was, therefore, relatively higher for the dancers in the 1st Company. Conversely, exposure time for dancers in the 2nd Company, which had fewer performances and contract weeks, was considerably less.

The incidence of injuries (injuries/1000 hours of exposure) in our organization ranged from a high of 0.57 (year 3) to a low of 0.18 (year 5). Dancers in the Swedish Ballet had a reported mean of 0.62 injuries per 1000 dance hours in a 5-year period<sup>15</sup> (Table 4). A comparison of injuries in dancers with injuries in athletes per 1000 exposure hours suggests that dancers experience a lower injury incidence. Reported injury rates in athletes include 1.4 injuries per 1000 training hours in figure skaters<sup>12</sup>; 3.4 to 4.6 injuries per 1000 exposure hours in endurance sports (running and rowing), contact sports (soccer), noncontact sports (tennis, gymnastics, basketball), and explosive sports (sprint and long jumping)<sup>24</sup>; and 6.2 to 7.3 injuries per 1000 exposure hours in male soccer players.<sup>10,14</sup> However, it is difficult to make meaningful comparisons between studies because of the lack of standardized definitions of injury and differences in participation rates.

To our knowledge, this is the first report of injuries in a modern dance organization. Therefore, we could only compare our results with those reported in similar studies of ballet companies. The low incidence of injuries in this modern dance organization after the intervention program began may reflect the influence of several factors. Injury risk may be less in modern dance than in ballet. Depending on the choreography, modern dancers may dance barefoot, in jazz shoes, or in heels (female dancers). Although there are occasional exceptions, female dancers in modern dance do not contend with the risks of dancing en pointe. Choreographic styles of the Alvin Ailey repertoire include Horton, Graham, ballet, West African, and jazz. The different dance styles vary the stresses to the body and perhaps cause fewer muscular imbalances than occur when only one dance technique is used. Much of the modern dance choreography at Alvin Ailey requires continuous dancing for up to 30 minutes by all dancers in the cast. This is likely to place greater aerobic demands on the dancers than the pas de deux and solo interludes in classical ballet, which last only 3 to 5 minutes. Perhaps the greater cardiovascular training required by modern choreography decreases mistakes caused by fatigue.

Although the definition of injury in this study was based on cost, the majority of new workers' compensation cases involved lost time. The timeliness of appropriate, quality care provided by specialists, as well as the on-site establishment of the intervention program, which allowed early

return of dancers to rehearsal and performance, all contributed to the reduction in time loss.

### Patterns of Injury

Patterns of injury by body region were similar to those reported in ballet companies. Lower extremity injuries accounted for an average 58% of injuries in this study (range, 45% to 71%), similar to the 57% to 75% rate reported in ballet companies (Table 4).<sup>6,15,20</sup> Of the lower extremity injuries, foot and ankle injuries were the most common (average, 34%; range, 23% to 57%) in our study, similar to the average 37%<sup>6</sup> and 38%<sup>20</sup> reported in two ballet companies. Lower back and pelvic injuries accounted for an average 17% of the injuries (range, 0% to 30%), similar to the 12% to 23% reported in two ballet companies.<sup>6,20</sup>

The literature on sports and dance injuries suggests that older age (with subsequent longer duration as a professional) is a risk factor for injury.<sup>4,8,13,23</sup> However, we found that before the establishment of our comprehensive management program, the younger dancers (those in the 2nd Company) accounted for the greatest incidence of injury as well as the greatest number of injuries per dancer. This is similar to findings reported by Solomon et al.<sup>19</sup> in ballet dancers. These findings suggest that young dancers may require a transitional program to assist them in managing the new stresses of professional dance.

Solomon et al.<sup>19,20</sup> reported that injuries in ballet dancers in their study were most prevalent in the first third of the season, suggesting a problem in the transition from relative inactivity to intense activity. At Alvin Ailey, a large proportion of injuries occurred during the 10-week rehearsal period at the beginning of their fiscal year. An average of 37% of the injuries (range, 29% to 42%) occurred during the rehearsal period, which only accounted for 25% of the total number of contract weeks. Periods of inactivity never exceeded 3 weeks. Although having an inactive period before intense rehearsal may contribute to an increased incidence of injuries, the constant movement repetition during rehearsal of newly choreographed sequences probably caused most of the overuse injuries seen during this period. Similar lengths of inactivity occurred between the New York City season and the US tour, but there were no increases in injuries after these inactive periods.

The greatest percentage of *trauma* injuries occurred during performances (54%), with performance hours accounting for 27% (1st Company) of dance exposure hours. However, compared with sports injury incidence, the overall incidence of injury during performances did not resemble the incidence of injury during games, which may exceed four times the rate of injury during practice.<sup>3</sup> In the 1st Company, injury rates during performances averaged 1.5 times the rates during all other time spent dancing (rehearsal, technique class, and warm-up), but were 0.91 times the rates during the new repertoire rehearsal period.

### Comprehensive Management Program

The benefits of the comprehensive management program were twofold. First, overuse problems were more effectively managed before they became serious injuries. Second, immediate triage prevented overutilization of medical services, thereby decreasing workers' compensation-related expenditures. Annual self-insured expenditures were minimal.

The National Institute of Occupational Safety and Health, in evaluating small business efforts to reduce worker injuries, has identified several key issues.<sup>9</sup> The most relevant to this project is the following: the process of injury prevention is built on relationships and it takes time for trust in the process to develop. The first half of year 3, during which the comprehensive management program was implemented, was transitional. It took several months to create and implement a flowchart of case management, outfit an on-site physical therapy room, and educate company administrators and dancers about the program. These factors may explain why no changes were seen in that 1st intervention year.

Savings in human costs are not easily quantifiable. Our in-house program has permitted an ongoing dialogue with the dancers that includes education about efficient body mechanics and errors in technique. This helps the dancers to overcome technical or choreographic difficulties that may be stressful to their bodies. Company administrators believe that the intervention program has made the responsibility of health care less burdensome and dancers believe that the administration cares about their well-being.

There is cumulative evidence that chronic work stressors can accelerate degenerative musculoskeletal processes.<sup>5,11,22</sup> The 54% increase in utilization of preventive physical therapy services may reflect the effectiveness of therapy in reducing the daily toll of dancing at the elite level. An analysis of physical therapy utilization by body region determined that 60% of visits were for the lower extremity, 19% for the foot and ankle, and 23% for lower back and pelvic complaints. Foot and ankle complaints (visits for preventive therapy) increased in year 5. This may be attributable to the new repertoire, which may have been more stressful to that area. No concurrent increase in foot and ankle injuries was found, which emphasizes the success of the primary prevention program.

Over the 3-year program, increasing numbers of dancers incorporated cross-training programs into their regimen. These programs included aerobic conditioning (treadmill, stationary bike, or swimming), reducing imbalances (strengthening weak muscles and stretching tight muscles), and addressing technique problems (including studying floor barre, yoga, or alternative "body work," such as Pilates training). The implementation of cross-training programs with increased utilization of preventive physical therapy may be reflected in the decreased incidence of new workers' compensation cases involving overuse. In year 1, the incidence was 76%; in year 5, it decreased to 10%. Traumatic injuries, such as metatarsal fractures and herniated lumbar discs, accounted for 5% of the new workers' compensation cases in years 4 and 5, down from a peak of 24% and 27% in years 2 and 3 (Fig.

1B). It is possible that improvements in general conditioning may minimize mistakes caused by fatigue and decrease traumatic injury rates.

### Limitations

A limitation of this project is the small sample size, which was dictated by the size of the organization under study. This study lacked a control group with no intervention. A randomized control trial, although optimal, was impractical in the small organization reported on here. However, the dance organization served as its own control in the repeated measures design. It is possible that the physical therapy coverage available to the 1st Company during their New York City season and US tour during years 1 and 2 influenced their injury rates.

### SUMMARY

Occupational musculoskeletal injuries have accounted for over 85% of workers' compensation claims in the United States.<sup>16</sup> The use of various forms of managed care has increased 150% since 1991.<sup>2</sup> This report illustrates how a comprehensive management program can be effective and tailored to the special needs of a modern dance organization. The benefits of comprehensive management included more effective management of overuse problems before they became serious injuries and triage to determine appropriate medical intervention, thereby preventing overutilization of medical services. Both dancers and management believe that having medical coverage is not a luxury but a necessity for optimal health and well-being, and both groups strongly support the continuance of this comprehensive management program.

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