Injuries in a Modern Dance Company
Effect of Comprehensive Management on Injury Incidence and Cost

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Abstract

Injury costs strain the finances of many dance companies. The objectives of this study were to analyze the effect of comprehensive management on injury patterns, incidence, and time loss and examine its financial impact on Workers Compensation premiums in a modern dance company. In this retrospective-prospective cohort study, injury was defined as any physical insult that required financial outlay (Workers Compensation or self insurance) or caused a dancer to cease dancing beyond the day of injury (time-loss injury). Injury data and insurance premiums were analyzed over an eight-year period. Injuries were compared using a mixed linear model with phase and gender as fixed effects. It was found that comprehensive management resulted in 34% decline in total injury incidence, 66% decrease in Workers Compensation claims, and 56% decrease in lost days. These outcomes achieved substantial savings in Workers Compensation premiums. Thus, this study demonstrates the effectiveness of an injury prevention program in reducing injury-related costs and promoting dancers' health and wellness in a modern dance company.

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Work-related musculoskeletal disorders are responsible for a sizeable percentage of health and financial expenses in the United States, accounting for over 85% of Workers Compensation (WC) claims.[1] Estimated direct costs range from 13 to 20 billion dollars annually,[1,2] and from two to ten times that amount in indirect costs.[3-6] Three of the most important factors that determine WC premiums are the classification assigned to the employer, the amount of payroll generated by the employer, and the past experience modification ratio (EMR) of the employer.[7] EMR is a formula used by insurance companies to gauge both past cost of injuries and probable risk of future injuries. Experience rating gives more weight to accident frequency than to severity of injury. For example, employer A has one loss totaling $50,000. Employer B has ten losses at $5,000 each, totaling $50,000. Although the total cost of injury is the same, Employer B will have a higher EMR. An EMR of 0.85 indicates that the employer experiences fewer claims than others within the same classification, and that employer consequently receives a 15% premium credit. An EMR of 1.15 incurs a 15% surcharge. An EMR of 1.0 is considered the industry average.

Performing artists are an occupational group at high risk for work-related musculoskeletal disorders. In professional dance companies, annual percentages of injured dancers range from 67% to 95%.[8-12] The costs associated with these injuries strain the finances of many dance companies. This is particularly true of modern dance companies, which typically have smaller budgets than ballet companies. Several dance companies have instituted in-house medical and physical therapy services to reduce the financial impact of injuries to company members.[8,9,11,13] Solomon and colleagues[11] reported a 21% decrease in the annual percentage of injured dancers and savings of $1.2 million in workers compensation insurance premiums in a major ballet company. Bronner and colleagues[8] previously reported a 45% reduction in annual percentage of injured dancers, 64% decline in WC case incidence, and 60% decrease in lost workdays in a large modern dance company. However, the financial benefits of the program were not examined. The objectives of this study were to expand Bronner's original five-year analysis of injury incidence, time loss, and injury pat-

terns to eight years and examine the program's financial impact on Workers Compensation premiums.

Materials and Methods

Subjects

Study subjects were dancers of the Alvin Ailey American Dance Theater (first company, 15M/15F dancers) and the junior company, Ailey II (second company, 6M/6F dancers). First and second company members had a mean age of 27.3 ± 0.3 years and 22.3 ± 0.7 years, respectively. Mean years in the company was 4.5 ± 3.9 years for first and 0.5 ± 0.2 years for second company. Any dancer performing less than 30 days annually or who had been with the company for less than three months was not included.

Experimental Protocol

A team representing company administration, artistic staff, dancers, and medical staff developed the comprehensive management program. Full details of the case management services were previously published.[8] For the sake of clarity, the eight-year study was divided into three phases: pre-intervention (two years prior to program onset), early intervention (program years 1-3), and late intervention (program years 4-6). During the two-year pre-intervention (Pre-Int) phase, no case management or regular on-site medical services were available. Limited physical therapy services were provided for the first company's New York season and U.S. tour. Beginning in the first year of the early intervention (Early-Int) phase through the end of the late intervention (Late-int) phase, daily on-site physical therapy services were provided during rehearsal periods and backstage before all performances. All physical complaints reported by dancers were evaluated by the on-call physical therapist or physician to determine the need for further medical referral. A WC case was opened for all injuries incurring medical bills greater than $500. Injuries costing less than $500 were paid by the company. A large rehabilitation company (HealthSouth Corporation) sponsored the Early-Int phase. The Ailey organization covered all expenses thereafter.

Injury definitions and classifications by mechanism, severity, location, and type were based on published recommendations.[14,15] Injury was defined as a physical insult that required financial outlay (WC or self insurance) or caused a dancer to cease dancing beyond the day of injury (time-loss injury). Injury mechanism was defined as either trauma or overuse. Traumatic referred to an injury resulting from a specific, identifiable event, overuse to injuries due to repetitive stress without a single, identifiable event. Injury severity was defined by number of days lost from dance; minor injuries were ≤ 7days, moderate injuries > 7 but ≤ 28 days, and severe injuries > 28 days away from dance. Hours of dance exposure were based on a 40-hour week times the number of contract weeks times the number of dancers. During touring weeks, a 40-hour week of dancing may have included company class, rehearsal, lecture-demonstrations (lec-dem), and one or two performances daily (matinee and evening). The number of dancer exposures (events) was the sum of all performances, lec-dems, and rehearsals.[14]

Pre-intervention financial and injury-related data were collected retrospectively from the company controller, stage manager reports, and individual dancer files (which were cross checked with data from the New York Compensation Insurance Rating Board). The in-house medical team collected early and late intervention data prospectively. All epidemiologic research was consistent with and approved by the University Institutional Review Board.

Data Analysis

Mean Pre-, Early-, and Late-intervention injuries were analyzed in SPSS (Version 15.0, SPSS Inc, Chicago, IL) using a mixed linear model with phase (Pre-Int, Early-Int, Late-Int) and gender as fixed effects. Phase was also used as the indicator of repeated effect with a compound symmetry covariance structure. Differences were considered significant at the $p < 0.05$ level. Cost-benefit analysis was calculated using direct (savings in WC insurance premiums) and estimation of indirect costs (lost workdays, lost productivity of injured dancer, claims processing). Injury incidence, incidence rate per 1000 hours, and incidence rate per 1000 exposures were calculated as follows:

1. Annual injury incidence = # of injuries / # dancers,
2. Annual injury incidence rate per 1000 hours = (# injuries / # hours dancer-exposures) * 1000, and
3. Annual injury incidence rate per 1000 exposures = (# injuries / # dancer-exposures) * 1000.

Results

Over the eight years, the first company's annual contract averaged 41 ± 3 weeks, with 24 ± 6 weeks spent in national and international touring. This group (30 dancers annually) danced an average of 49,275 ± 4,224 hours, and performed at 240 ± 16 events annually. The second company's annual contract averaged 35 ±2 weeks, touring 19 weeks in smaller U.S. cities and venues. This group (12 dancers annually) danced an average of 16,800 ± 994 hours and performed at 108 ± 7 events annually. Rehearsal periods, when a new ballet was choreographed or repertory was reconstructed, lasted an average of 11 ± 2 and 13 ± 2 weeks annually for the first and second companies, respectively. The first company had only 29 dancers for part of the season in post-intervention years three and six. This was taken into account in the annual hours of exposure calculations.

Injury Incidence

During the study period, 87 different individuals danced for the organization. Seventy-Five of these (dancers employed multiple years were only counted once) sustained a total of 217 injuries (2.9 injuries per injured dancer) (Table 1). No career ending injury occurred. Cumulative injury incidence over 8 years was 65%; Pre-Int injury incidence was 87%, while Early- and Late-Int injury incidences

were 78% and 37%, respectively. Cumulative WC injury incidence was 42%. Pre-Int WC injury incidence was 82%. This declined to 40% in Early-Int and 17% in Late-Int. Cumulative time-loss injury incidence was 32%. Pre-Int time loss injury incidence was 31%, Early-Int was 48%, and Late-Int time loss injury incidence was17%. There were no differences in total, WC, or time-loss injuries by gender, but there were differences ($p < 0.05$) by phase.

Seventy-three injuries were recorded in the Pre-Int phase. Ninety-five percent (n = 69) were WC injuries and 36% were time loss injuries. Of the 98 injuries recorded in the Early-Int phase, 51% were WC injuries and 62% were time loss injuries. There were 46 injuries in the Late-Int phase. There were equal numbers of WC and time-loss injuries (n = 21) in this period. Although Pre-Int and Early-Int total injuries did not differ, there were fewer Late-Int total injuries than both Pre-Int ($F[2,126] = 8.84$, $p < 0.05$) and Early-Int ($F[2,114] = 8.84$, $p < 0.01$). Pre-Int WC injuries exceeded Early-Int ($F[2,140] = 13.83$, $p < 0.01$) and Late-Int WC injuries ($F[2,155] = 13.83$, $p < 0.01$)], and Early-Int exceeded Late-Int WC injuries ($F[2,140] = 13.83$, $p < 0.05$]. Early-Int average annual time loss injury incidence (48%) exceeded those recorded during the Pre-Int (31%) [$F(2,107) = 11.66$, $p < 0.05$] and Late-Int phases (17%) [$F(2,107) = 11.66$, $p < 0.01$].

Although the second company (n = 12) represented only 29% of the cohort, they sustained 38% of total injuries and 41% of WC injuries in the Pre-Int phase (Table 1). Pre-Int total injury incidence in this group was 117%. After institution of the intervention program, incidence declined to 75% in Early-Int and 19% in Late-Int. WC injury incidence declined at an even greater rate. Compared to Pre-Int incidence of 117%, Early-Int WC injury incidence was 47%, while Late-Int incidence was only 3% (Table 1).

Exposure

Mean annual injuries per 1,000 hours of dance exposure was 0.41 (range: 0.23 to 0.67, SD ± 0.17). Comparing the three phases, mean annual injuries per 1,000 hours was highest in Pre-Int (0.52), followed by Early-Int (0.48), and lowest in Late-Int (0.25). Injuries per 1,000 dancer exposures decreased from a high of 114 to a low of 52 (Table 1).

Injury Location and Diagnostic Category

Lower extremity injuries accounted for 60% of total injuries. Of these 52% were at the foot and ankle, 24% at the knee, and 8% each at the leg, thigh, and hip. Incidence of foot and ankle injuries ranged from 31% (Pre-Int 2) to 10% (Late-Int 2, see Table 2). Low back and pelvis accounted for

Table 1 Annual Injury Incidence and Days Lost

Phase	Year	Company	Injured Dancers	WC Injuries	Total Injuries	Days Lost	Injuries per injured dancer*	Injuries per 10^3 exposures	Injuries per 10^3 hours	EMR
Pre-Int	1	Total	25	33 (79%)	34 (81%)	237	1.4	114	0.48	0.92
		1st	15	19 (63%)	20 (67%)	72	1.4	85	0.37	
		2nd	10	14 (117%)	14 (117%)	165	1.4	122	0.81	
	2	Total	27	36 (86%)	39 (93%)	144	1.4	114	0.56	1.09
		1st	18	22 (73%)	25 (83%)	142	1.4	92	0.47	
		2nd	9	14 (117%)	14 (117%)	2	1.6	117	0.83	
Early-Int	1	Total	26	33 (79%)	48 (114%)	112	1.8	166	0.67	1.06
		1st	18	21 (70%)	34 (113%)	76	1.9	147	0.63	
		2nd	8	12 (100%)	14 (117%)	36	1.8	131	0.81	
	2	Total	21	10 (24%)	32 (76%)	86	1.5	108	0.48	1.38
		1st	18	7 (23%)	26 (87%)	74	1.4	112	0.53	
		2nd	3	3 (25%)	6 (50%)	12	2.2	53	0.36	
	3	Total	14	7 (17%)	18 (43%)	105	1.3	58	0.28	1.46
		1st	8	5 (17%)	11 (37%)	102	1.3	43	0.23	
		2nd	6	2 (17%)	7 (58%)	3	1.2	70	0.44	
Late-Int	1	Total	13	8 (19%)	16 (38%)	67	1.2	64	0.27	1.32
		1st	11	8 (27%)	13 (43%)	59	1.2	58	0.29	
		2nd	2	0 (0%)	3 (25%)	8	1.2	30	0.19	
	2	Total	12	7 (17%)	15 (36%)	83	1.3	52	0.23	0.96
		1st	11	6 (20%)	14 (47%)	37	1.3	58	0.28	
		2nd	1	1 (0%)	1 (8%)	46	1.0	10	0.06	
	3	Total	14	6 (14%)	15 (36%)	48	1.1	57	0.24	0.89
		1st	11	5 (17%)	12 (40%)	45	1.1	53	0.28	
		2nd	3	1 (8%)	3 (25%)	3	1.2	19	0.11	

EMR = Experience Modification Ratio. *Dancers employed multiple years were counted in each year.

Table 2 Annual Injury Incidence by Anatomical Region

	Pre-Int 1	Pre-Int 2	Early-Int 1	Early-Int 2	Early-Int 3	Late-Int 1	Late-Int 2	Late-Int 3
Foot/ankle	19%	31%	24%	24%	19%	19%	10%	14%
Leg	2%	7%	2%	5%	2%	0%	2%	5%
Thigh	2%	10%	2%	2%	2%	2%	2%	2%
Knee	17%	2%	17%	17%	2%	2%	7%	10%
Hip	2%	7%	7%	5%	0%	2%	0%	0%
LB/Pelvis	19%	0%	31%	14%	7%	2%	7%	5%
Trunk	0%	0%	2%	2%	0%	7%	2%	0%
UE	0%	7%	12%	5%	10%	0%	0%	0%
Head & Neck	7%	5%	7%	0%	0%	2%	5%	0%
Other	12%	21%	10%	2%	0%	0%	0%	0%
Total	81%	90%	114%	76%	43%	38%	36%	36%

Table 3 Annual Injury Incidence by Diagnostic Category

	Pre-Int 1	Pre-Int 2	Early-Int 1	Early-Int 2	Early-Int 3	Late-Int 1	Late-Int 2	Late-Int 3
Fracture & Bone Stress	0%	0%	5%	5%	10%	0%	2%	0%
Joint (non-bone) & ligament	60%	36%	38%	38%	17%	24%	19%	24%
Muscle & tendon	10%	31%	45%	21%	12%	12%	10%	10%
Contusions	0%	0%	10%	2%	0%	0%	2%	2%
Lacerations & skin lesions	2%	0%	0%	0%	0%	0%	0%	0%
Other	10%	26%	17%	10%	5%	2%	2%	0%
Total	81%	93%	114%	76%	43%	38%	36%	36%

16% of total injuries, with annual incidence ranging from 31% (Early-Int 1) to 0% (Pre-Int 2). Approximately 9% of injuries were categorized as "other." These included dehydration, "missing diagnosis," or injuries that involved multiple body parts (e.g., lip laceration, ankle sprain, and concussion due to a fall during partnering).

Joint (non-bone) and ligament (49%), followed by muscle and tendon (29%), accounted for most injuries in this population. Annual incidence of joint and ligament injuries ranged from 60% (Pre-Int 1) to 17% (EarIy-Int 3, see Table 3). Muscle and tendon injury incidence ranged from 45% (Early-Int 1) to 10% (Pre-Int 1, Late-Int 2 and 3). Fractures and bone stress represented 5% of total injuries, with an incidence ranging from 10% (Early-Int 3) to 0% (Pre-Int 1 and 2, Late-Int 1 and 3). Contusions and lacerations or skin lesions accounted for 2% and less than 1% of total injuries, respectively.

Injury Mechanism and Severity

Overuse injuries comprised 71%, while traumatic injuries represented 28%, of total injuries. The remaining 1% was "other" (dehydration and hyperthermia and unexplained groin pain). Annual incidence of overuse injuries ranged from 81% (Early-Int 1) to 19% (Late-Int 2 and 3, Fig. 1A). The majority (86%) of all injuries were minor, resulting in 7 or fewer days away from dance. Minor injury incidence ranged from 102% (Early-Int 1) to 29% (Late-Int 2 and 3, Fig. 1B). Moderate injuries were 11%, while severe (> 28 days) injuries were 3% of total injuries. Moderate injury incidence ranged from 12% (Pre-Int 2 and Early-Int 1) to 2% (Late-Int 1).

Injury-Related Costs

In this study, annual EMR ranged from 1.46 (Early-Int 3) to 0.89 (Late-Int 3, Table 1). Annual days lost due to injury decreased over the intervention period. Average annual lost day costs decreased 65% from Pre-Int phase to Late-Int (Table 1). During the Early-Int phase, a private sponsor covered all program operating costs (i.e., purchase of equipment and supplies, physical therapy services, travel expenses for the physical therapist). The organization's expense was limited to self insurance injury payments. Operating costs incurred by the dance organization in Late-Int phase totaled $216,254. Had the first three years of the program not been sponsored, the estimated cost would have doubled to an estimated $440,000.

Discussion

Studies show that physical therapists provide efficient and cost effective direct access care for the general population with musculoskeletal conditions.[16-22] This study validates these findings and expands them to include elite level modern dancers. The present study describes the injuries to members of a modern dance company and the cost effectiveness of an in-house comprehensive management program directed by physical therapists. The main outcomes of this program were a 66% decrease in WC injury incidence, 14% decrease in average annual time loss injury incidence, and 65% decrease in lost days, culminating in cost savings of $860,766 ($637,020 unsponsored)

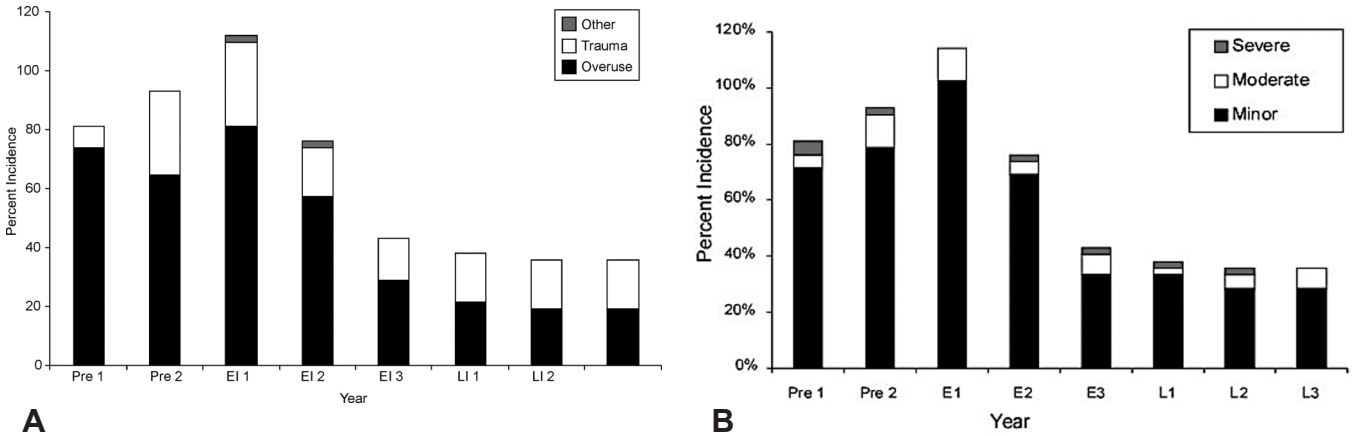

Figure 1 Annual injury incidence. **A**, Incidence of overuse and traumatic injuries. **B**, Incidence of total injuries by time-based severity classification. Note: Figures represent incidence (not percent) of injuries, explaining why Y axis range is 0% to 120%. "Other" included non-musculoskeletal injuries or those for which diagnosis was unknown. Pre = pre-intervention, EI = early intervention, LI = late intervention.

and a 3.98 (1.45 unsponsored) benefit-cost ratio.

Injury Rates and Patterns

Prior to the program, injuries were on the increase (Table 1). During the first year of the program, WC injury incidence decreased 7% from the previous year. Conversely, total injuries increased 18%, and time-loss injuries increased 35%. The first half of Early-Int year 1 was transitional, requiring injury protocol education and equipping of the on-site physical therapy room. Additionally, the convenient on-site access to medical practitioners led to an influx of dancers to the physical therapy room with myriad acute and chronic complaints. Therapists identified a number of chronic complaints that warranted referral to the company orthopedist or time away from dancing, resulting in an increased number of recorded injuries. When deemed necessary, dancers were limited to "observation only" to allow the injured body part to recuperate and prevent development of a moderate to severe injury. As dancers received proper medical advice and care, medical referrals slowed and injury rates declined until they stabilized during the Late-Int years.

A comparison of our injuries per 1,000 dance hours (0.23 to 0.56) with sports injuries suggests that dancers experience lower injury incidence than gymnasts (1.6 vs. 2.2)[23,24] and figure skaters (1.4 vs. 5.1).[25] Previous studies of ballet companies have reported comparable annual percentages of injured dancers and patterns of injury by body region but differing rates of injury. These differences are mainly due to variations in injury definitions.[25,26] In an attempt to facilitate comparisons, we have reported injury using three injury definitions (self report, financial, time-loss), and we report injury incidence per 1,000 hours and per 1,000 exposures.

Solomon and colleagues,[11] using a "self report" definition of injury, found cumulative injury incidence of 182%. Had we included all physical complaints reported by the dancers, our cumulative total injury incidence would have tripled, putting it within the same range.

Defining injury as involving monetary cost, cumulative injury incidence in this study was 52% (range: 26% to 90%), with 2.7 injuries per injured dancer. There were 75 injuries (financial definition) per 1,000 dancer exposures, and 0.33 injuries per 1,000 dance hours. We calculated an injury incidence of 69% (309 injuries/446 dancers) from Garrick and colleagues' published data on the San Francisco ballet.[9] This incidence is comparable to our findings. However, it is important to note that the Garrick study included 200 students who performed intermittently with the company. Had the students not been included, cumulative injury incidence would have been 126%, or more than double our findings.

Utilizing a time-loss definition, our cumulative injury incidence was 32% (range: 14% to 62%), with 2.8 injuries per injured dancer. There were 46 injuries per 1,000 dancer exposures, and 0.20 injuries per 1,000 dancer hours. This cumulative injury incidence is far lower than that calculated from published data on the Swedish ballet (100%).[10] A plausible explanation for this difference is that Nilsson and colleagues[10] used a time-loss injury definition for prospective injury recordings and a "medical consultation" definition of injury for retrospective recordings. As suggested earlier, when on-site medical care is available dancers may be more likely to seek consultation for every physical discomfort they feel, resulting in a high incidence of "medical consultation" injuries and hence an inflated incidence of total injuries.

Performance Versus Rehearsal Injury Incidence

There is no general consensus in the dance medicine community as to when (rehearsal or performance) most injuries occur. Scialom and colleagues[27] studied a professional contemporary Brazilian dance company and found that injuries occurred mainly during their rehearsal period. This is in contrast to Bowling,[28] who

surveyed 141 dancers in seven UK-based dance companies and reported that just over one-third of injuries occurred during performance. At the Boston Ballet[11] injuries were most prevalent in the opening months of the season. Similarly, in our previous study,[8] a large percentage of injuries occurred during the ten-week rehearsal period at the beginning of the company's fiscal year. In the current analysis, an average of 48% of total injuries occurred during performance weeks (Fig. 2A). However, when normalized to exposure, there were an average 0.6 injuries per 1,000 hours of rehearsal versus 0.08 injuries per 1,000 hours of performance (Fig. 2B). Comparing the percentage of injuries during rehearsal and performance gives the misleading impression that injuries occur most often during performance, when in fact the incidence of rehearsal injuries was almost eight times that of performance. This clearly underscores the importance of calculating injuries in terms of exposure hours.

Injury-Related Costs

While injury prevention and intervention programs have no effect on employer classifications and payroll, they can have a marked influence on EMR. In this company, the physical therapy-based injury management program resulted in a 64% decrease in EMR (from 1.38 to 0.89). It is important to note that EMR is calculated from the number of WC claims incurred in a three-year period that ends one year before the effective date of the policy to which the experience rating will apply. In other words, EMR for Early-Int 3 (1.38) was based on the number of claims filed in Pre-Int 1, Pre-Int 2 and Early-Int 1. As a result, the total effect of the intervention program on EMR could not materialize until Late-Int 2 (EMR = 0.96). Therefore, the four consecutive years of surcharges incurred during the early intervention period were not due to failure of the program, but rather to large numbers of WC claims in years preceding intervention. Had the number of WC claims in early and late intervention years remained at pre-intervention levels, EMR would have been at least 1.46, resulting in surcharges of $215,404 or more during the late intervention years alone.

Cost-Benefit Analysis

True financial savings on injuries consists of both direct (WC insurance premiums) and indirect (changes in dancer productivity, satisfaction, and risk) costs. Operating costs for this comprehensive program were $216,254 ($440,000 unsponsored). Direct financial savings in WC premiums as a result of lower EMR totaled $215,404. Indirect costs are less tangible and therefore more difficult to measure.[3-6] Using a moderately conservative estimate of four times direct cost savings,[3-6] indirect cost savings were in the neighborhood of $861,616. After subtracting program costs ($216,254) from the resulting savings in direct and indirect costs ($1,077,020), the net benefit of the in-house program is $860,766. Based on this calculation, the benefit-to-cost ratio is 3.98 ($860,766/$216,254). Had the first three years of the program not been sponsored, net benefit would have been $637,020, resulting in a 1.45 ($637,020/$440,000) cost benefit-to-cost ratio. In other words, for every dollar spent the program returned $3.98 ($1.45 unsponsored). Given that indirect costs have been estimated at up to ten times direct costs, the four times direct costs estimate used in this study is both acceptable and conservative. The 3.98 sponsored versus 1.45 unsponsored benefit-to-cost ratio suggests that organizations may require a period of sponsorship to successfully implement similar programs.

Summary

The comprehensive management program produced a positive effect on injury incidence, time loss, and injury-related costs. Several factors ac-

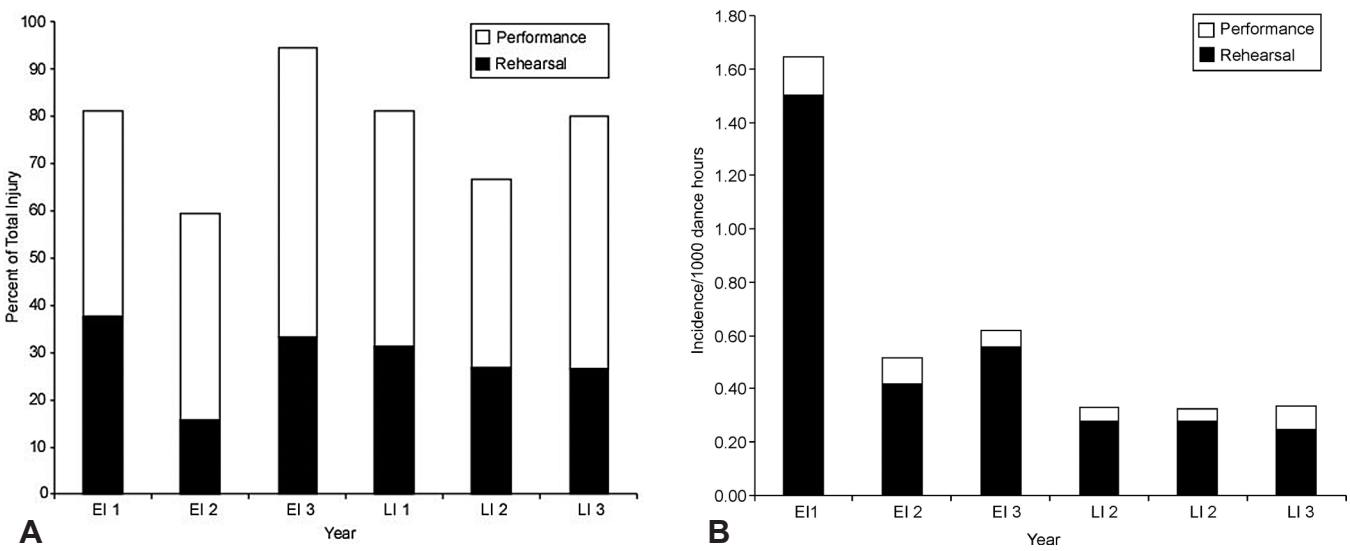

Figure 2 Comparison of rehearsal and performance injuries. **A**, Performance and rehearsal injuries as a percentage of total injuries. **B**, Performance and rehearsal injuries relative to 1,000 performance and rehearsal exposure hours. Note: If we were unable to determine when an injury occurred it was excluded. EI = early intervention, LI = late intervention.

count for these benefits. An in-house dance medicine program provided dancers with access to trusted specialists who understood their repertory. Without having to travel to and from therapy, there was no lost rehearsal or class time. This eased dancers' anxiety about any absence. Established relationships with management facilitated communication between physical therapists and rehearsal and artistic directors to address stressors in choreography (e.g., ensuring that movement was performed in the most biomechanically sound manner, or modifying when necessary). Early attention to physical complaints and easy availability of therapy prevented injuries from developing or increasing in severity. Immediate access to specialized rehabilitation and conditioning after injury allowed for early return to dance via restricted duty.

Acknowledgments

We thank the dancers and the artistic and administrative staff of the Alvin Ailey American Dance Theater for their participation in and support of this program. Additional thanks to Corrie A. Mancinelli, P.T., Ph.D., for her editorial assistance, and Evangelos Pappas, P.T., Ph.D., O.C.S., and Mariya Shiyko, Ph.D., for their statistical guidance.

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