Dancers must develop a number of physical capacities to high levels in order to succeed in the challenging world of dance. They must optimize flexibility, coordination, alignment, movement efficiency, endurance, and strength. Dancers used to resist the idea of building strength, perhaps because strength is associated with characteristics that seem to be in conflict with aesthetic qualities that are important in many concert dance forms. There appears to be no scientific evidence to support the concern that strength training might compromise aesthetic characteristics in dancers. But, there is evidence to show that dancers can gain strength without adding bulk or losing flexibility by using a balanced program that integrates strengthening and stretching.

Strength is one of the key capacities that allow dancers to relevé and balance with grace and confidence, to land from a leap with absolute control and in near total silence, and to perform movements at extreme ranges of motion with a fluidity that makes them captivating to watch. Improving strength can also improve efficiency by allowing fewer, stronger muscle fibers to manage movements and allowing unneeded muscle fibers to rest and prepare for subsequent movement. Building strength may also reduce injury risk.

Strength is an explicit element in some athletic endeavors, but it remains a hidden ability in dancers. Dancers use strength to negotiate the choreography they perform in service to their art. They seek to develop a highly refined strength that emphasizes the most efficient muscles for performing dance movements. Doing so can make a dancer’s movements appear nearly effortless. Sometimes the best indication that dancers have enough strength and coordination is when a movement seems to happen without any effort. Of course, most movement requires effort to start, slow, stop or suspend. The dancer’s challenge is to make that effort secondary to the expressive intent of the movement being performed.

The purpose of this article is to show how supplemental strengthening for the spinal extensors (back muscles) can provide benefits that are important to dancers and their performance. It is based on a study that evaluated the effects of supplementary strengthening on university dancers’ back strength, arabesque height, and number of classes and rehearsals missed due to back pain.

The exercises used in dance classes may strengthen some muscles while allowing others to become weak. The pattern can be amplified when dancers are allowed, or even encouraged, to use momentum to perform movements that are intended to build strength. Of course, the efficient use of momentum is an essential skill for dancers to develop. However, if momentum is used as a substitute for strength when performing strength-building exercises, dancers may miss the opportunity to develop the strength they need to manage challenging choreography. Dancers who repeatedly perform movements that they do not have sufficient strength to manage may learn to substitute compensatory movement patterns for more efficient ones to accommodate their strength deficiencies. This strategy is likely to reduce movement efficiency as well as skillful movement potential.

Weakness in the back muscles (spinal extensors) is a risk factor for back pain. Strengthening the back extensor muscles may help dancers avoid back pain while improving
their ability to perform dance skills such as arabesque. To perform extreme movements well and to perform most movements efficiently, a dancer must be able to control the center of his or her body.9,10 Dancers who are skillful in doing so can integrate their movements and create dynamic lines in space that are beautiful and expressive.

Strength can be sorted into three related abilities: 1) to exert force, 2) to exert force repeatedly over time, 3) and to exert force quickly enough to create the power needed to leap, for example. Power can also allow dancers to perform effortful movements quickly enough to manage a fast tempo in the music and choreography.11

Building strength safely requires thoughtful use of the principles of conditioning. To improve strength, we must choose a movement that uses the muscles we want to strengthen, perform that movement with control through its full range of motion, and increase the resistance, repetitions, duration or speed a little at a time.2 When challenging dancers to help them grow, teachers and trainers should watch for movement compensations that signal when enough is enough.6

If the load that dancers apply to their musculature remains constant over time, strength is unlikely to improve.4,5,11 In contrast, if a challenge is progressed gradually by asking dancers to manage a little more than they were able to manage during their last class, workout or rehearsal, strength can be improved with minimum risk to the dancers’ health. To improve strength, the challenge we ask dancers to manage must be greater than the dancers can already manage, but by just a little.

One of the challenges in building strength to support dance movement is finding ways to systematically increase the training load for the muscles to be strengthened.9 Strength can be developed safely by using the principle of progressive overload: Doing a little more today than the dancer was able to do perfectly yesterday.6 Adding resistance progressively is a common way to increase the training challenge. Choosing the right level of challenge for each dancer may require individual modifications.5

The purpose of the back strengthening study was to determine whether aspects of strength that are important to dancers could be improved with supplemental training. Six dancers made twice-weekly visits to a clinic where trainers guided them through exercises on equipment designed to focus effort on the spine extensors (MedX, Ocala, FL; Fig. 1). The dancers also completed a circuit of Nautilus (Vancouver, WA) exercises chosen to target complementary muscle groups (abdominal, rotary torso, hip extension, knee curl, knee extension). The resistance against which the dancers worked was adjusted to match each individual dancer’s gradually improving strength over the 6 to 10 weeks that the dancer trained. Resistance was the training stimulus that was increased progressively in this study but repetitions, duration or speed could be increased instead to emphasize other aspects of strength.

All six dancers in the study increased their back strength between 15% and 130%. When we re-tested the dancers as long as a year after training, all had strength levels well above their baseline levels. The strength training also improved the dancer’s arabesque height by an average of 3.6 degrees (Fig. 2). In addition, the number of classes and rehearsals the dancers reported missing due to back pain decreased. In social validity questionnaires the dancers completed at the end of the study, all the dancers said they were pleased with their strength gains and felt the work had improved their potential as dancers.


Figure 2 Strategy for measuring arabesque height.
The fact that most of the dancers retained their strength common among dancers and their teachers. That strength building requires persistence, a skill that is shown paired images of each dancer's arabesque with of their time. In addition, the dancers' ballet teacher was of the training, and they felt the training was a good use of the training, and they felt the training was a good use dancers said their strength had improved a lot as a result produced. In ratings collected at the completion of training, appreciated the changes that the strengthening program variance of dance abilities.

Improving dancers' strength may beneficially influence a we may have seen beneficial adaptations there as well. other dance abilities such as torso control while jumping, improve with increased back strength. If we had measured arabesque height as an example of a dance skill that might improve with increased back strength. If we had measured other dance abilities such as torso control while jumping, we may have seen beneficial adaptations there as well. Improving dancers' strength may beneficially influence a variety of dance abilities.

The discipline of science advises against reaching too far beyond what the data can directly support, but some interpretation and extrapolation are necessary. Here are a few implications from the back strengthening study that have special relevance for dancers and teachers.

First, it looks like dancers can gain substantial improvements in back strength with as little as 15 hours of carefully designed and supervised supplemental strength training. The specialized training equipment used in this study made it easy to isolate the spinal extensors as the dancers performed the strengthening exercises. We propose that dancers' finely tuned ability to control and isolate movement could allow them to use exercises that do not rely on specialized equipment to achieve most of the benefits experienced by the dancers in our study. Conducting a new study to assess this possibility is on our list of projects.

We saw increases in strength when the dancers were tested 4 to 6 weeks after training began, and the dancers' strength continued to improve for all 6 to 10 weeks of training offered to the dancers. Other studies using a similar training approach have shown strength gains continuing for as long as 20 weeks of training. These results reveal that strength building requires persistence, a skill that is common among dancers and their teachers.

The fact that most of the dancers retained their strength gains when they were re-tested as long as a year after the supplemental training had concluded is encouraging. A possible explanation is that once the dancers gained new strength that was helpful to their dancing, they were able to use that new strength in their daily dance training and, thereby, retain the gains achieved by the supplemental training. It may be that once a threshold is passed, new levels of strength can be maintained by normal dance training regimens. Future research could be designed to address this question directly.

An outcome of special interest to dancers is that arabesque height increased when the dancers' back strength increased. The concurrent improvements suggest that improving strength in relevant muscle groups can improve dancers' performance of specific dance skills. We measured arabesque height as an example of a dance skill that might improve with increased back strength. If we had measured other dance abilities such as torso control while jumping, we may have seen beneficial adaptations there as well. Improving dancers' strength may beneficially influence a variety of dance abilities.

The dancers and their ballet teacher noticed and appreciated the changes that the strengthening program produced. In ratings collected at the completion of training, dancers said their strength had improved a lot as a result of the training, and they felt the training was a good use of their time. In addition, the dancers' ballet teacher was shown paired images of each dancer's arabesque with no indication of which image was taken before training and which was taken after training. The teacher selected many more of the after-training arabesques as better for the trained dancers but not for the untrained dancers. These qualitative assessments suggest that strengthening can contribute meaningfully to dancers' development as performing artists.

**Implications**

Scientific research can provide a foundation for effective training in dance but research results are rarely perfectly matched to the training questions we want to answer. The discipline of science advises against reaching too far beyond what the data can directly support, but some interpretation and extrapolation are necessary. Here are a few implications from the back strengthening study that have special relevance for dancers and teachers.

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**Special Considerations**

To optimize progress in a training endeavor such as improving strength, dancers must push their bodies hard enough to develop new abilities, but not so hard as to create overuse symptoms. When strengthening, dancers and teachers need to watch for accumulating soreness, muscle cramping or inflammation (heat, redness, swelling or pain) and be ready to change how they are working if symptoms appear. In the back strengthening study, we checked with the dancers frequently to see how their bodies were adapting to the training. One dancer missed his morning technique class the day after training due to soreness in the muscles he had worked while training. His absolute gains in strength turned out to be the highest of all the dancers who participated in the study, so his temporary soreness appears to have been an indicator of growth. Had the soreness persisted for more than a day or so after training, we would have changed the way he was working during training.

Although not a focus in the back strengthening study, it should be noted that overtraining (pushing the body too hard for too long) can result in chronic soreness, fatigue, moodiness, and sleep disturbances that can compromise performance and reduce training effectiveness. Periodization—training hard for a while followed by working less hard for a while—can help dancers avoid overtraining. Severe cases of overtraining may require weeks or months of rest from intensive physical activity.

In strength training, the inability to complete another repetition with perfect alignment and execution shows that we are working at our limit. Discovering limits provides information that can be used to determine a goal for the next training session. In the back study, dancers were instructed to continue moving through their full range of motion for 3 continuous minutes while using the MedX equipment. The clinic staff set the exercise resistance. If the dancer was able to finish the 3-minute session with little effort, the staff increased the resistance at the next training session. In the back strengthening study, the staff reduced the resistance for the next training session. If the dancer was unable to complete the whole 3-minute session, the staff reduced the resistance for the dancer's next training session.

In traditional approaches to strength training, it was common to repeat a set of repetitions three to five times with a brief rest between sets to optimize gains. Recent research suggests that doing a variety of exercises that challenge the same muscle group can have similar benefits. Using a variety of strengthening exercises is compatible with the need to build the diverse movement capabilities that dancers must develop to succeed.
Once strength is gained, it must be used regularly or the gains will disappear.13 Dancers experience detraining during breaks from dancing and when changing teachers or dance repertoire. Detraining can also happen if new strength is developed but used only rarely. One of our ballet instructors designs his classes to use strength developed earlier in the term at least once a week to help dancers retain their gains.14 He also encourages dancers who have a conspicuous weakness to seek help from our conditioning staff to develop a cross-training program to address the limitation in a context where it can be the focus of the dancer’s effort.

The dancers in the back strengthening study retained much of the strength they gained during training for as long as a year after their supplemental training had concluded. Apparently, they were using their new strength enough in the dancing they were doing to keep their strength from diminishing. Two implications can be drawn from this result: 1) Capacities that dancers use regularly may not require perpetual supplemental training to maintain them, and 2) Building strength beyond a functional threshold may allow dancers to achieve a training effect while dancing that they may have been unable to access before becoming stronger.

It is surprising to some dancers that dynamic flexibility can be improved with strength training.4,15 As the muscles on one side of a joint become stronger, they may gain the ability to stretch the muscles on the other side of the joint to greater lengths, increasing the amplitude of the movement and actively stretching the muscles that need to become longer. We did not directly assess this possible influence in the back strengthening study, but it may be an interesting topic for future research.

Finally, it is worth noting that challenging dancers’ strength limitations without putting them at risk for injury may require more individualization than tradition dictates. Each dancer is likely to have a different level of strength to start, and each dancer will be able to progress at a different rate than their colleagues.5 The dancers in the back strengthening study trained individually so the resistance they were working against could be calibrated to their own body’s gradually increasing abilities across sessions. Some dancers were able to manage double the resistance of other dancers in the study. Individualizing the training allowed for this possibility.

Our experience in working with other dancers addressing a variety of training challenges has convinced us that individualizing some of our dancers training is essential for meeting their needs. By adapting training to each dancer’s abilities, we can help them correct imbalances and weaknesses with a reasonable investment of time and avoid creating compensatory movement patterns that may have to be corrected later. As we address individual limitations using individualized training approaches, dancer participation and performance in technique classes, rehearsals and performances seems to improve. Systematic study of this interactive effect is another topic that is ripe for future research.

The back strengthening study offers insights into how dancers can benefit from supplemental strengthening. The contribution of any single experiment to our collective understanding of how best to train dancers is incremental. Yet, small improvements in understanding can accumulate to create helpful new perspective on how to expand the effectiveness, efficiency, and relevance of the training we are providing for tomorrow’s dance artists.

References
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