

# The IADMS Bulletin for Dancers and Teachers

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Volume 6, Number 2, 2015

**Editor-in-Chief**

*Gayanne Grossman, P.T., Ed.M.*

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## **Copy Editor**

Jane Baas, M.F.A., M.A.

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### Letter from the Editor

Dear Dancers and Teachers,

The *IADMS Bulletin for Dancers and Teachers* will be celebrating its seventh anniversary in 2016! Thank you for standing by us. A very special thank you to Ken Endelman and Balanced Body for supporting us from the very beginning. I wish to personally thank Marliese Kimmerle, Ph.D. for continuing to write the article summaries and provide invaluable consultation. We are grateful that Jane Baas, M.F.A., has joined our editorial board. IADMS and the *Bulletin* team are honored to have such impressive people supporting our efforts to bring our readers a scientific approach to improving teaching pedagogy free of charge.

To celebrate our seventh year, the Education Committee will be updating our *Bulletin* team, our look, and use of social media. Look for big announcements in the next issue. Please let me know if there is something you would like to see us include. You can email me at [Bulletin@IADMS.org](mailto:Bulletin@IADMS.org).

In this issue, we are pleased to have articles from four talented dance science researchers. Tom Welsh, Ph.D., has written an article on the effects of a spinal strengthening program for dancers. He discusses pain and arabesque height. We are publishing our first article on nutrition with more on that to come in future issues. Derrick Brown, M.Sc., and Matthew Wyon, Ph.D., are sharing their article on the positive nutritional effects of eating carbohydrates before dance class. Kimberly Hutt, M.Sc., has written an article on what happens to balance in dancers by training with the eyes closed. This is a very important and a newer concept in training techniques to improve balance.

Thank you to our loyal readers and welcome to our new ones.

Sincerely,  
Gayanne Grossman P.T., Ed.M.  
Editor-in-Chief

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# Greetings from the IADMS Education Committee

We hope you enjoy the latest *Bulletin for Dancers and Teachers*, produced in collaboration with the IADMS Education Committee. The *Bulletin* is designed to present cutting edge research in dance medicine and science, highlighting the applicability of the research into practice for dancers and dance teachers. The *Bulletin* augments other Education Committee resources, all of which can be found on the IADMS website under “[Resources](#).” Follow the link to find resource papers, posters and information on upcoming events for educators. You can also subscribe to the [IADMS Facebook](#) page to receive news and links to blog posts for dance educators.

In addition to the *Bulletin for Dancers and Teachers*, the IADMS Education Committee has a Dance Education Network that publishes a quarterly newsletter on IADMS events and information. If you would like to subscribe to this newsletter, please send an email with your name and preferred email address to [education@iadms.org](mailto:education@iadms.org).

The 2016 IADMS conference will be held in Hong Kong October 20-23. As a part of this meeting, the Education Committee hosts “A Day for Teachers” – designed for dancers and dance educators new to the organization. Please check the IADMS website for more information on this in 2016.

Finally, the IADMS Education Committee recognizes outstanding dance educators each year. The first two recipients of this award are Janice Plastino (USA) and Janet Karin (AUS). If you are interested in nominating someone for this award, we will include the requirements in the next *Bulletin for Dancers and Teachers* as well as in the Dance Education Network Newsletter.

Please enjoy this issue, and please circulate it widely to your colleagues and students.

Margaret Wilson, Ph.D.  
Chair, IADMS Education Committee

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# Back Strengthening for Dancers

Tom Welsh, Ph.D., Florida State University, Tallahassee, Florida, USA

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.<sup>2</sup> 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.<sup>3</sup> 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.<sup>4</sup>

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.<sup>5</sup> Building strength may also reduce injury risk.<sup>3</sup>

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.<sup>6</sup> 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.<sup>1</sup>

The exercises used in dance classes may strengthen some muscles while allowing others to become weak.<sup>4,6</sup> 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.<sup>7</sup> 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.<sup>8</sup> Strengthening the back extensor muscles may help dancers avoid back pain while improving

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*This article is based on research reported in Welsh, TM, Jones, GP, Lucker, KD, Weaver, BC. Back strengthening for dancers: A within-subject experimental analysis. J Dance Med Sci. 1998;2(4):141-148. I thank my colleagues for their essential contributions to the original research and encourage readers seeking additional details to read the full report in the Journal of Dance Medicine & Science.<sup>1</sup>*

The preparation of this article benefitted from insightful comments offered by colleagues Margaret Wilson, Gabriel Williams, Veoletta Range, Gayanne Grossman, and Jane Baas. Questions and comments should be directed to: Tom Welsh, Dance Faculty, Florida State University, 202 Montgomery Hall, Tallahassee, FL 32306-2120; twelsh@dance.fsu.edu; 850-644-1024.

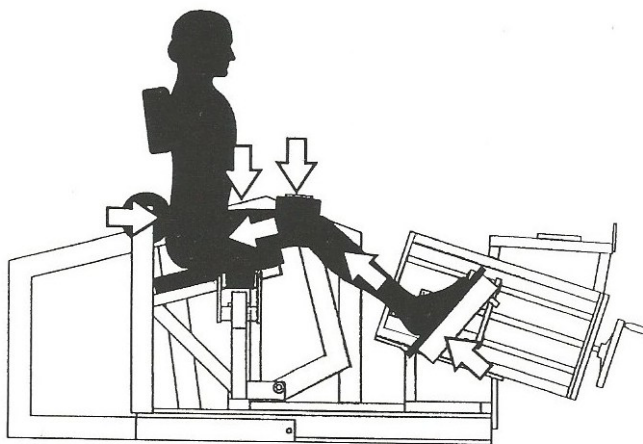
their ability to perform dance skills such as arabesque. To perform extreme movements well and to perform most movements efficiently, a dancer must be able to control the center of his or her body.<sup>9,10</sup> Dancers who are skillful in doing so can integrate their movements and create dynamic lines 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.<sup>11</sup>

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.<sup>2</sup> When challenging dancers to help them grow, teachers and trainers should watch for movement compensations that signal when enough is enough.<sup>6</sup>

If the load that dancers apply to their musculature remains constant over time, strength is unlikely to improve.<sup>4,5,11</sup> 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.<sup>9</sup>

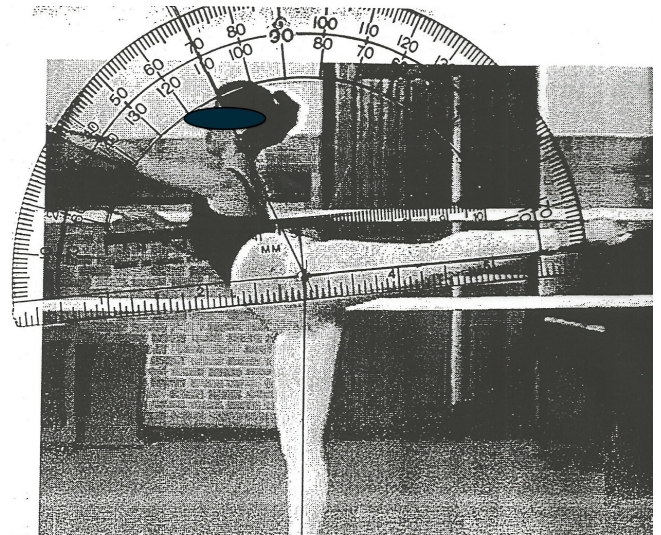


**Figure 1** MedX back strengthening equipment stabilizes the pelvis to focus effort on the back extensors. Reprinted from Holmes B, Leggett S., Mooney V, Nichols J, Negri S, Hoeyberghs A. Comparison of female geriatric lumbar-extension strength: Asymptomatic versus chronic low back pain patients and their response to active rehabilitation. *J Spinal Disord.* 1996;9(1):17-22.

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.*<sup>6</sup> 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.<sup>5</sup>

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.

## 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.

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.<sup>12</sup> 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.

## 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.<sup>5,13</sup> 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.<sup>13</sup>

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. 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.<sup>13</sup> Using a variety of strengthening exercises is compatible with the need to build the diverse movement capabilities that dancers must develop to succeed.<sup>6</sup>

Once strength is gained, it must be used regularly or the gains will disappear.<sup>13</sup> 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.<sup>14</sup> 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.<sup>4,15</sup> 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.<sup>5</sup> 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.

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# IADMS Education Committee

## Recommendations for Strength Training

- Choose an exercise that focuses effort on the muscles you want to strengthen.
- Use perfect alignment; stop if you begin to compensate.
- Add enough resistance so you can complete the movement almost 8 times without compensating.
- Move with control through the full range of motion.
- Gradually increase repetitions until you can do 12 without compensating.
- When doing 12 repetitions is easy, increase the resistance by a small amount (~5%) and do as many repetitions as you can without compensating (~8 reps).
- Repeat the pattern of increasing repetitions, then adding a small amount of resistance until you have a little more strength than you think you need.
- Perform the exercise two or three times a week to increase strength.
- Perform the exercise at least once a week to maintain strength.
- Increase repetitions to 20 or more (without compensation) to build endurance.
- Consult a fitness trainer for help if you want to build power.



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# The Effect of Moderate Glycemic Energy Bar Consumption on Blood Glucose and Mood in Dancers

Derrick Brown, M.Sc., Donders Institute for Brain, Cognition and Behaviour, Radboud University, The Netherlands and Matthew Wyon, Ph.D., The University of Wolverhampton, and The National Institute of Dance Medicine and Science, UK

**D**ance class, rehearsal, and stage performance all entail periods of high-intensity intermittent physical activity (HIIT).<sup>1</sup> Therefore, dancers should ensure adequate energy reserves to perform their daily activities.<sup>2</sup> A variety of factors determine which type of fuel muscles utilize during exercise<sup>3</sup> however, it has long been established that performing athletes use carbohydrate as a primary energy source more than those leading an inactive lifestyle.<sup>4</sup>

Ingesting quality carbohydrates is recommended as essential for dancers. Given that most dance classes take place in the morning, it has been suggested that dancers eat a well-balanced breakfast containing carbohydrates, fats, and protein as a means of fuelling this activity. The aim of this study was to determine the effect of a moderate glycemic index (MGI) energy bar (designed to break down gradually and help stabilize blood sugar levels) or fasting on dancers' blood sugar levels and their perceived pleasure-displeasure response during the first dance class of the day.

The glycemic index is a relative measure of how rapidly and how much a portion of food raises blood glucose (also called blood sugar) levels. Foods with higher index values (e.g. white bread) raise blood sugar more rapidly than foods with lower glycemic index values (e.g. lentils). The glycemic index number associated with a particular type of food indicates the food's effect on blood glucose level. A value of 100 represents an equivalent amount of pure glucose.

The World Health Organization (WHO) recommends at least 55% of total energy come from a variety of carbohydrate sources for optimum health,<sup>5</sup> while for sporting populations the recommendation is 60%.<sup>6</sup> From studies of dietary practices among elite and student dancers, and from the observations of dieticians, exercise physiologists, and sport nutritionists, the general consensus is that many dancers do not achieve the adequate nutrition needed for

optimal physical health and performance.<sup>7</sup> Nutrition often takes a subordinate role when aesthetic principles become more important than energy balance.<sup>8</sup> Dancers' demanding schedules, in addition to a potential lack of nutritional knowledge, may also prohibit them from maintaining an optimal dietary intake.<sup>9</sup>

In Western countries, between 3-34% of the population miss eating breakfast.<sup>10</sup> Numerous factors can influence skipping breakfast, among them socioeconomic status,<sup>11</sup> perception of lack of enjoyable food choice,<sup>12</sup> economics,<sup>13</sup> and misconceptions regarding what constitutes a healthy meal. In addition, skipping breakfast is more frequent among girls, older adolescents, and persons from low socioeconomic groups.<sup>14</sup> Published research into the possible reasons for and prevalence of skipping breakfast in dance populations is scarce. However, research examining the energetic deficiencies in dancers' diet allows for the probability that breakfast skipping is prevalent in this group.<sup>5</sup>

Little research has been conducted experimentally on the effects of glycemic index in the dietary patterns of dancers; however, it has been suggested that this information would offer a guideline for nutritional planning in this population.<sup>2</sup> No known work has been published utilizing behavioral measures that reveal how a dancer feels as a result of dietary intervention. One way to assess affect is via psychological measurement. The Feeling Scale is a test that examines not "what" but gives context to "how" one feels as a result of exertion. The Feeling Scale has been used in sport and exercise psychology as a dichotomous measure of pleasure-displeasure.<sup>16</sup> Using the glycemic index and feeling scale as forms of measurement, the aim of this study was to examine how carbohydrate consumption or fasting impacted blood sugar and its effect in pre-professional dancers.<sup>17</sup>

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## Methodology

### Participants

Ten physically healthy female contemporary dance students volunteered to participate in this study. All participants were currently taking daily dance classes four to six times

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This article is adapted from Brown D, Wyon M. The effect of moderate glycemic energy bar consumption on blood glucose and mood in dancers. *Med Probl Perform Art.* 2014 Mar;29(1):27-31.

per week at least four hours per day and were injury free at the time of the study. Participants were excluded for contraindications such as chronic smoking, dieting, pre-existing gastrointestinal conditions, and medication or drugs known to influence fat or carbohydrate metabolism. All participants reported regular menses and none were knowingly pregnant.

**Procedure  
Study Design**

On testing days, all the participants fasted the night before. Their blood sugar was tested before, during and after dancing. Their mood was tested before and after dancing. Some dancers did not eat and others ate an energy bar within 20 minutes of dancing. Everyone was allowed to drink water. The MGI bar contained approximately 47.3 g of carbohydrate, 2.1 g of fat, and 9.6 g of protein. The bar had to be consumed within 15 to 20 minutes dependent on dancer’s self-chosen warm-up. Blood sugar was measured using an Accu-chek Compact Plus® (Roche Diagnostics, Mannheim, Germany).

The Hardy and Rejeski *Feeling Scale* (FS)<sup>17</sup> is an 11-point single-item bipolar rating scale ranging from -5 (very bad) to +5 (very good). Participants were asked to rate how they felt at that particular moment. FS has the advantage of most other self-report scales of being easily and quickly administered during exercise, thus turnover from test to return to class was minimal (±2 min per participant).

**Dance Class**

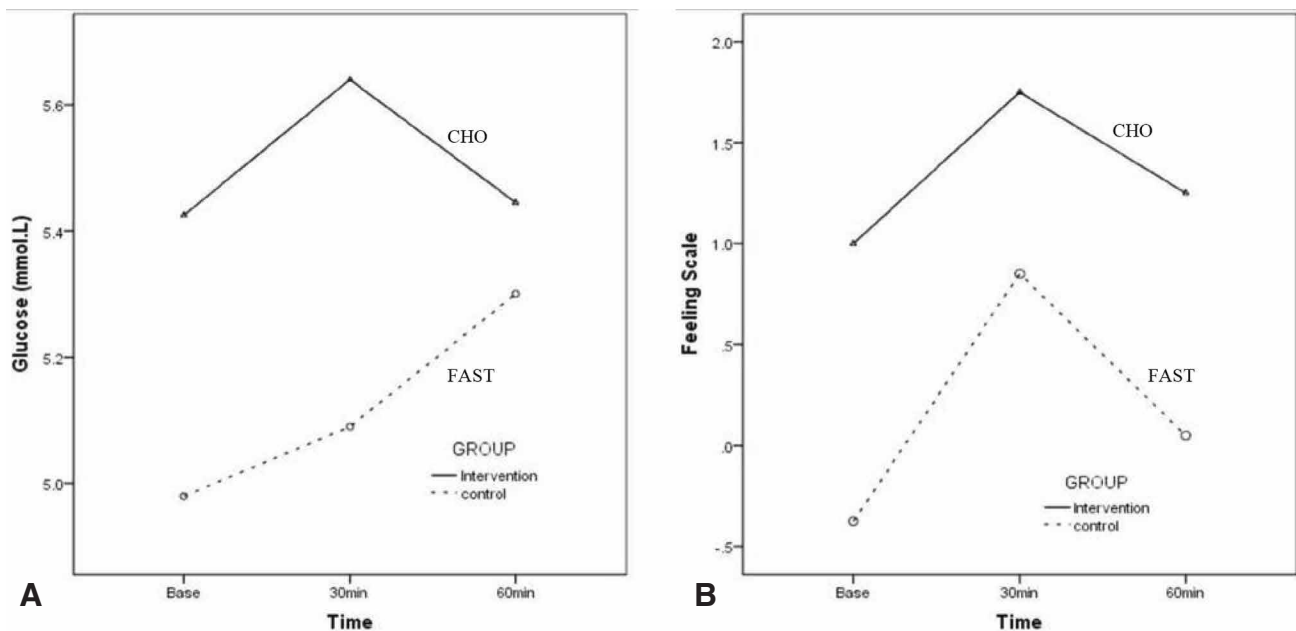
As the participants were already familiar with the contemporary dance class and instructor, no preliminary test or

acclimatization protocol was necessary. The students were observed in their normal class by the principal researcher on three occasions prior to testing. This gave information as to the pace and flow of the class in order to know the best timing to remove students from class.

**Results**

There were differences seen in blood sugar levels at baseline between both groups. However, statistical analysis revealed these results were not significant. Further, results revealed that the dancers who did not eat experienced a rise in their blood sugar rapidly from baseline to 30 min., with a momentary decline from the 30 min. to 60 min. time points, which are comparable to previous studies in athletes.<sup>18</sup> In the carbohydrate trial, which included dancers who ate the energy bar, the rise from baseline to 30 min. was minimal, with a subsequent marginal decline in sugar levels from 30 min. to the final time point. Neither group’s blood sugar concentrations dropped below baseline measurements. Other studies confirm similar findings in which water, when compared with a high glycemic index meal, produced an increase in postprandial (after a meal) glycemic response.<sup>19</sup> This means that there is a relationship between blood sugar levels and carbohydrate consumption (Fig. 1A).

The second aim of the present study was to examine whether skipping breakfast had an effect on dancers’ pleasure-displeasure state during class. Previous research has shown that blood sugar influences mood, with a low blood glucose congruent with a more negative mood.<sup>20</sup> Moreover, in studies with cognitively demanding tasks, as seen in the present study, falling levels of blood glucose have been associated with feeling less energetic.<sup>21</sup> Within



**Figure 1** Mean glucose concentrations (A) and changes in pleasure-displeasure FS values (B) at rest (baseline) and at 30 min and 60 min of dance class after ingestion of an MGI energy bar (CHO, intervention group, solid line) or water (FAST, control group, dashed line). Reproduced from: Brown D, Wyon M. The effect of moderate glycemic energy bar consumption on blood glucose and mood in dancers. *Med Probl Perform Art.* 2014 Mar;29(1):27-31. With permission.

the present study, overall ratings of pleasure were higher in dancers who consumed the energy bar (Fig. 1B).

At baseline, the carbohydrate-eating group felt neither pleasure nor displeasure, while the fasting group felt displeasure. In both groups, pleasure ratings became more positive during the second time point (30 min), followed by a decline in pleasure for both trials towards the final time point (60 min). Our results are similar to those reported by Backhouse et al. who examined the influence of carbohydrate beverage ingestion on affect (pleasure-displeasure) and perceived exertion during a high-intensity intermittent soccer match.<sup>22</sup>

## Discussion

The main purpose of this study was to examine the effects of ingesting an energy bar on physiological parameters and pleasure-displeasure affect in a study implemented during an actual dance class. The ingestion of an energy bar compared with ingestion of water prior to dance class had a positive impact on blood sugar levels during the subsequent dance class. Exercise creates a powerful stimulus for blood sugar uptake into skeletal muscle when energy needs are met solely by reserves and the intestines are empty. Blood sugar can constitute 15 to 30% of the energy requirement of the working muscle during moderate exercise and upwards of 40% during high intensity events.<sup>23</sup> Research has shown that carbohydrate ingestion prior to exercise with either low or high glycemic index foods maintained higher blood sugar concentrations<sup>24</sup> and decreased plasma (blood) lactate concentrations during exercise or post exercise.<sup>25</sup> Others have indicated a rapid increase in hyperinsulinemia (high blood insulin levels), with increased glucose uptake and decreased free fatty acids availability as a possible cause.<sup>26</sup>

Wyon et al.<sup>27</sup> have shown that that the center portion of a dance class is an intermittent form of exercise that does not place significant stress on the aerobic system. Thus in class, high-intensity intermittent physical activity, or blasts of explosive exercise interspersed with periods of much less intense effort, conceivably occurs only in the final stages of class via center, across the floor, and jumping combination.

## Conclusion

Although often suggested among colleagues in dance medicine and science, there has been little scientific evidence published to support meal manipulation within a dance population, with select food items for this single purpose. This study established that manipulating the student dancers' diet towards food items rich in complex carbohydrates contributed to the overall impact of blood sugar levels. The current research thus corroborates the current tenet that choice of macronutrient intake—in this case, carbohydrates, confers a discernible effect on blood glucose levels.

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# Eyes-Closed Dance Training for Improving Balance of Dancers

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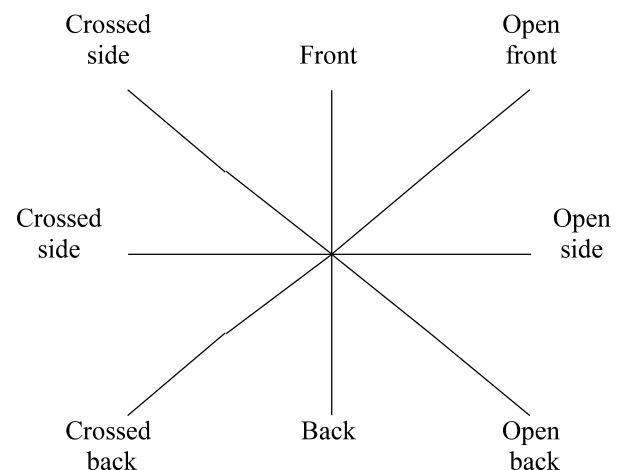
Research has shown that dancers rely heavily on visual cues to maintain balance.<sup>1</sup> Visual conditions in dance performance environments range from traditional lighted stages to open spaces and museums, typically very different from rehearsal and class environments where dancers can be dependent on mirrors for visual feedback. Consequently, when performing, a dancer's balance may suffer.

Balance requires three main mechanisms involving visual stimulus, mechanisms within the inner ear, and physical sensory awareness. This sensory awareness is known as proprioception. Dancers who rely more on proprioception than visual cues for balancing tend to be more stable. In addition, within dance and sport, it is widely accepted that proprioception reduces the risk of injury due to improved joint and postural stability. These points should further encourage dance educators to seek ways to enhance proprioception among dancers.

It is possible for dancers switch from one balance mechanism to another.<sup>2,3</sup> For example, they may rely predominantly on visual cues for balancing when their eyes are open, yet shift to proprioceptive strategies when they close their eyes. A similar shift might be required under stage lighting conditions, or other unfamiliar performance environments. Interestingly, a study on classical ballet dancers demonstrated that while dancers have excellent balance abilities, when they close their eyes and try to balance, they are no better than non-dancers.<sup>4</sup> This finding suggests that a dancer's ability to switch from using visual cues to proprioceptive strategies for balancing could be improved. It has also been noted that dance practice alone does not improve proprioceptive mechanisms for balancing, necessitating balance practice beyond the dance class.

The concept of specificity within sports training and testing has been acknowledged, and is growing within the dance field, for example, dance fitness testing<sup>5,6</sup> and balance testing.<sup>7</sup> Researchers have identified that in order for balance training to be successful, it must be trained using the same skills that are required during performance.<sup>8,9</sup> Therefore, when training dancers it seems appropriate to select a balance-training program with specificity to dance practice. Furthermore dance training programs often require long and exhausting hours of dance classes, therefore identifying means of integrating balance specific training within dance classes may reduce the necessity for additional practice and is likely to improve compliance.

In this study, a group of pre-professional dancers were given an eyes-closed, dance-specific training program to enhance their proprioceptive mechanisms for balancing and to seek improvements in dynamic balance. Eighteen elite pre-professional ballet dancers were randomly assigned to either a control (eyes-open) or experimental



**Figure 1** The eight spoke grid and directions used for all variations of the SEBT. NB: These directions are based on the subject facing the front spoke and using her right leg as the dominant “reaching” leg.

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(eyes-closed) group for the intervention. The balance abilities of all dancers were tested before and after a four-week balance intervention. Balance was tested using previously researched modifications to the Star Excursion Balance Test (Figure 1) (mSEBT), designed to challenge a dancer's balance.<sup>7</sup> The mSEBT uses speed to complete the test, and assesses how far the dancers can reach their working leg before toppling as indirect measurements of dynamic balance.

### Balance Training

The intervention consisted of dance-specific, eyes-closed sequences integrated into the dancers' daily ballet class, and on a weekly basis were designed to progressively challenge the dancers' balance. During the intervention period the control group undertook the same program with their eyes open. The balance exercises formed the first center practice

exercise of the class and were performed five days per week for 4 weeks.

The results showed that balance among the dancers in the experimental (eyes-closed) group improved significantly when compared to the control (eyes-open) group across all balance tests. Improvements in time to complete the tests were up to 16%. During the variations of the test that measured reach distances, improvements were also greater among the experimental group, but the difference was less noticeable. Theorizing that the test variations collectively represent dynamic balance, overall, these results suggest that a four-week, eyes-closed, dance-specific training program can improve the dynamic balance ability of dance students.

The most notable improvements were elicited when time to complete the tests were measured. It is interesting that research has shown that when the speed of a moving limb increases, more equilibrium control is required to maintain

Week 1	Port de bras	Start in 5th position croisé. Arms, 1st, 2nd, extend and down (4 counts) 1st, 5th, open to 2nd (4 counts) Port de bras forward and back (8 counts) Chasse to 4th point foot derriere (4 counts) Transfer through 4th, plié to point devant (4 counts) Ronds de jambe en d'ehors with quarter turn to croisé (4 counts) Transfer through plié back to point devant croisé close 5th (4 counts) Repeat all other side Total 64 counts
Week 2	Battement tendu	Start in 5th position croisé Tendu devant, close 5th, tendu devant, close 5th (4 counts) Tendu à la seconde, lower heel, point foot close 5th derriere changing direction to croisé other side (4 counts) Repeat on other leg (8 counts) 4 x tendu à la seconde en arriere closing in 5th and changing feet each time (4 counts) 4 x tendu à la seconde en avant closing in 5th and changing feet each time (4 counts) Repeat all Total 64 counts
Week 3	Battement jeté	Start in 5th position croisé 2 x jeté devant, on 3rd jeté – 2 x piqué to 45° close 5th (4 counts) Repeat à la seconde, changing 5th each time finishing closing derriere to change croisé direction and leg (4 counts) Repeat with same leg derriere (4 counts) Jeté à la seconde with 2 x piqué close devant, mini developpe à la seconde, close derriere (4 counts) Start all on other side Total 32 counts
Week 4	Developpé and grande battement	Start in 5th position croisé Developpé devant, take to a tendu, close 5th (4 counts) Grande battement devant, grande battement à la seconde, close derriere (4 counts) Repeat on other side (8 counts) Balancé side using front leg, balancé side using other leg (4 counts) Soutenu towards front leg (4 counts) Repeat balancé and soutenu sequence (8 counts) Repeat all (64 counts)

balance.<sup>8</sup> This is particularly useful information for dancers and dance educators given the dynamic nature of dance, as it suggests that balance training not only improves dynamic balance, but may also improve speed.

The only version of the test that did not reveal noteworthy improvements involved randomizing the order of the direction in which the working leg was reached. This was an unexpected and interesting finding, however it could be explained by predictive balance control. Predictive balance relies on anticipatory postural adjustments, which can be accounted for by learned movements.<sup>9</sup> The dancers in this study were classical ballet students. It could be argued that sequences within a ballet class can be predictable; for example, if you were to ask a ballet dancer or teacher, “What comes next: coupé, chassé, pas de bourrée, glissade...?”, you would anticipate the answer to be “jeté.” The mSEBT followed a predictable en dehors (clockwise if using the right leg as the working leg) and en dedans (counter-clockwise) direction. When the direction of the working leg was randomized, all of the dances within the study struggled. This is useful information for dance educators as it could suggest that choreographing less predictable sequences within a dance class could further challenge balance mechanisms and ultimately improve dance performance.

In summary, the results from this study indicate that eyes-closed training can improve the balance abilities of elite female pre-professional ballet dancers. These results imply that closing the eyes during dance training is an effective way to stimulate a shift from visual to proprioceptive dependency for balance control, thereby improving balance regardless of visual conditions in the surrounding environment, and potentially reducing the risk of injury. It

is hoped that these findings may encourage dance educators and practitioners to incorporate eyes-closed training into dance practice.

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# Abstracts from the Current Literature

Marliese Kimmerle, Ph.D.

**Rodrigues-Krause J, Krause M, Reischak-Oliveira A. Cardiorespiratory considerations in dance from class to performance. *J Dance Med Sci.* 2015;19(3):91-102.**

There is now an extensive body of research on the topic of cardiovascular fitness and dance. In this comprehensive review paper the authors have summarized the results of numerous research studies that a) documented the CV fitness levels of dancers, b) examined the physical demands of dance performances, and c) proposed and evaluated supplementary fitness programs for dancers. They present the results of ten studies of the cardiovascular responses of dancers and found different physiological capabilities due to levels of experience, age and gender and, not surprisingly, according to dance form. The specific cardiovascular demands of different dance forms were reported from six studies, looking at performance demands in ballet, modern, jazz, tap, ballroom and aerobics and comparing those to class and rehearsal. The studies report much greater CV demands of performance and a concern that increased injury is possible due to dancers' fatigue and lack of strength. Overall, dance classes are not physically demanding enough to train dancers' fitness. While the center-floor section of the class appears to increase the intensity somewhat, the exercises are usually too short with a long rest periods. To deal with this divergence between class and performance demands, supplementary aerobic and strength training has been recommended and evaluated in six studies. Including additional fitness training within or supplementary to technical classes however is not an easy task. The choice of both dance fitness assessment protocols and training programs must be specifically adapted to the intermittent nature of dance characterized by a mixture of short series of explosive movements and sustained adagio demands. It also must be individualized to the dancer's physical capabilities, experience, dance style, and role in the company. It may however be difficult to add even a once a week supplementary fitness training to the already heavy physical and time demands of technical classes, rehearsals and performance. If this is not possible, there are recommendations

for integrating fitness training within the technique class by developing a continuous, medium intensity warm-up routine as well as increasing the duration or repetitions of center-floor exercises and decreasing rest time in between. The most effective training would appear to be High Intensity Interval Training (short bursts of high aerobic intensity exercise followed by short rest). An example offered is a 5-minute routine including 3 sets of 20-second sprint-like exercises such as sautés, followed by 2 minutes of active recovery such as a grande adagio sequence. This type of training appears to more closely mirror performance demands. Results from studies suggest that the time and effort expended for increased fitness training appear to be balanced by improved technical and artistic performance capabilities and injury prevention. The authors suggest it would be worthwhile for instructors and choreographers to consult fitness specialists to design a dance appropriate assessment and training regime suited to their dance form and the particular needs of the dancers.

**Angioi M, Metsios G, Twitchett A, Koutdakakis Y, Wyon M. Effects of supplemental training on fitness and aesthetic competence parameters in contemporary dance. *Med Probl Perform Art.* 2012;27(1):3-8.**

To follow the previous review, this study provides an illustration of the positive effects of a supplementary fitness program on contemporary dancers. Studies have indicated that in general dancers are not as fit as other athletes, and their class and rehearsals do not provide sufficient training for the cardiovascular and muscular power and endurance demands of performance. In modern dance these include repeated jumps and pliés per minute, frequent transitory movements to and from the floor, lifts, and high intensity bouts of movement with limited recovery time. A 6-week program that included two one-hour sessions per week of circuit training and whole-body vibration was developed and administered to half of a group of twenty-four female adult modern dance students and professionals. The other half (control group) participated in two extra one hour

technique classes per week. A pre and post fitness test was administered as well as an aesthetic competency test. The fitness assessment evaluated muscular power of the lower extremity using a vertical jump, upper body muscular endurance via number of press-ups from the knees per minute, and aerobic capacity using the Dance Aerobic Fitness Test that involves 20 minutes of contemporary dance sequences that progressively increase in intensity and speed. While a number of studies with dancers have illustrated that it is possible to measurably increase their muscular and aerobic fitness level with training, there is a scarcity of studies to show how this change in fitness affects their dance performance. Therefore the authors incorporated a previously developed dance aesthetic competence test that required the dancers to perform a 1 minute 30 second dance sequence. They were evaluated on such criteria as control of movement, spatial skills, accuracy of movement, technique, dynamics, timing, rhythmical accuracy, and performance qualities. The circuit-training program consisted of 10 stations of lower and upper body dance-specific exercises performed continuously for 30 seconds with 10 seconds in between series repetitions designed to improve aerobic capacity and muscular fitness. This was followed by whole-body vibration training consisting of performing a series of dance-specific static positions on a vibration platform, which is thought to enhance strength and power capabilities. At baseline testing there was no difference between the two groups. In post testing the training group showed significant increases in all fitness measures and in aesthetic competency, while the control group showed increases in only one measure, aerobic fitness, while decreasing or remaining unchanged in the others. The good news from this study is that it is possible to increase dancers' fitness level with only a 6-week program; the additional 2 hrs of training per week were manageable in addition to the typical 6-8 hr dance schedule. This increase in aerobic fitness, power and muscular endurance should help them meet the physical demands of performance better and avoid fatigue, and perhaps equally important for the dancers, simultaneously their aesthetic competency improved. One hopes these kinds of studies will help persuade institutions, companies and choreographers to incorporate supplementary fitness programs.

**Gontijo KNS, Candotti CT, Feijo GS, Ribiero LP, Loss JF. Kinematic evaluation of the classical ballet step "plié." J Dance Med Sci. 2015;19(2):70-76.**

Correct performance of the plié is an integral part of classical ballet and many other dance forms. There are general descriptive technical criteria for what the lower limb alignment in the hips, knees and longitudinal arches of the feet should be in order to be ideally technically correct and to avoid predisposition to injuries. This study used those criteria to develop a methodology for establishing quantifiable criteria using kinematics. This also allowed the authors to examine whether experienced dancers in fact performed the pliés using correct alignment. Twenty experienced adult bal-

let dancers were recruited for this study. Four video cameras recorded the performance of two demi and two grand pliés in both first and second position using 22 anatomical markers for the analysis. Analysis was made of midfoot stability, pelvic positioning, pelvic stability, and alignment between the knee and the foot and the data was examined for the static component of the plié and the dynamic transition component. Dancers showed correct midfoot stability, but were not correctly aligned in the pelvis. During the plié the pelvis was in neutral position (which the authors defined as pelvic angulation between 12 and 15 degrees) when the knees were extended but was in retroversion (defined as less than 12 degrees) in the majority of dancers during the plié. In terms of knee-foot alignment, on average the dancers presented with medial misalignment when the knees were flexed. Only four of the dancers had the proper knee alignment with the second toe. It appears even experienced dancers were not able to stay correctly aligned in their lower limbs according to the ideal plié criteria in the literature for classical ballet. This study has provided a methodology for carrying out a kinematic evaluation of the plié useful for dance researchers. For the dance instructor, the authors have provided a detailed description of the correct alignment in each area and have clarified the contribution that each aspect of misalignment can make to possible muscle, ligament and joint injuries, thus reinforcing the need to pay careful attention to correct alignment.

**Henley MK. Comparison of shape, space, and time judgments in expert dancers and novices. Evidence that production enhances perception. J Dance Med Sci. 2015;19(3):103-109.**

In most dance classes, instructor demonstrates a new skill or sequence for the students. The students then have to retain that image in memory in order to try to reproduce it for the first time. That means they have to identify the physical action performed, e.g. a jump, as well as observe the shape of the body and limbs, the direction or level in space, and the duration of the movement. Can one assume that experienced dancers would be more accurate observers, overall or of just some components? This study reviews neuroscience theory on visual processing, specifically the action/perception link to make the connection between dancers' experience and ability to perform an action and their perceptual ability as background to an experiment on dance observation by novice and expert dancers. The material developed for this study were 32 movement phrases, each composed of a series of four actions consisting of gross motor skills such as walk, jump, and balance. Each action had a unique configuration of arm, leg and torso, i.e. a shape, but was not recognizable as any codified dance movement, which would have provided a clear advantage to the experts. These same phrases were then manipulated so in one of the four segments, either the body shape, duration of movement or direction was changed, or no changes were made to any of the segments. Twenty experienced and 20 novice dancers were presented with these 32 pairs

of phrases, the original and then the manipulated phrase and asked to identify if the two phrases were the same or if they could identify a difference in shape, time, or direction. There was no difference in the ability of novices and experts in identifying the shape differences in the phrases. However, the expert dancers were significantly better at identifying the time, direction or no difference phrases. The author suggests that while novices were able to remember the shapes, the experienced dancers at the same

time also encoded time and direction. They had repeated past physical experience learning movements by connecting a movement's shape, direction and duration and that they were able to code them through a shared mechanism. From reading this study, one can perhaps extrapolate some suggestions for teaching a dance phrase to novices in order to help them form these links so they try to match shape with space and time.




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