# *STRENGTH TRAINING FOR DANCERS*

## *WHAT IS STRENGTH?*

Strength is the ability to produce force against some kind of resistance.

- An individual's physical strength is determined by two factors; the cross-sectional area of muscle fibers recruited to generate force and the intensity of the recruitment.

The skeleton functioning as a system of levers provides an interface between the muscular contractile force and the objects we wish to move.

- Absolute strength: Whoever can lift more weight is the stronger person.
- Relative strength: It is the absolute strength adjusted based on the bodyweight and size.
  - A dancer may have low absolute strength, but still be relatively strong.
  - Balance and posture are isometric (static contractions without any movement) displays of strength.
- Strength is the most important physical aspect of human performance.
- Strength is the essential foundation for all body movements and allows us to properly use endurance, flexibility and power.
- A dancer with extreme talent may still lack a certain strength to perform the movement at his maximal potential.

## *WHAT IS POWER?*

Physical power is the ability to produce force quickly.

- Power is used for turns, jumps, lifts and other quick movements.
- The concept of power is extremely important for every athlete. It directly affects the performance in all sports.
- Therefore, training programs that improve power should be used for all athletes and dancers
- «All other things being equal, the more powerful athlete will always beat the less powerful athlete». (Mark Rippetoe, 2006)

**Muscular strength** is the ability to exert maximal force in one single contraction, such as lifting a weight that you could lift only once before needing a short break.

**Muscular power** refers to a great force production over a short period of time, such as in fast leg kicks and explosive jumping.

**Muscular endurance** is when less force is sustained over a longer period of time such as in gallops, skips, pliés, and swings. Dancers often confuse endurance with strength, so it is sometimes useful to think of endurance as continuous and strength as maximal.

In dance you are required to jump, catch partners, move down on to the floor and up out of the floor at fast speeds, and perform other explosive movements. These movements require a level of muscular strength and power. While technique classes can improve muscular strength and power, it is not necessarily the main goal.

Some current dance technique classes are increasingly asymmetrical (practicing coordination on one side only) and are more focused on stylistic and artistic aspects of dancing rather than adequate repetitions to develop strength, power, and endurance. Therefore, you should do supplementary exercises for muscular strength, power, and endurance outside of your dance technique classes.

Without a certain baseline of these important abilities, you are more likely to incur musculoskeletal imbalances and injuries. Injuries developed from muscular imbalances or from lack of core strength in large, explosive movements are common.

# *DANCE KINESIOLOGY*

## *DANCE IS MOVEMENT*

- Therefore, it is an artistic display of strength. Having more strength does not necessarily mean that you can dance better than someone without strength, but increased strength and the ability to use it will always help you to reach your artistic potential.

- Dancing is an act that involves the whole body. Many muscle groups and joints are being used in many different and sometimes extreme ranges of motion. This and the fact that through repetitive movement patterns we create imbalances, increases the risk of injuries.

THE BODY OF A DANCER

- The aesthetic ideal for dancers has been formed through professional and social pressure.
- Being thin, flexible, low weight and low body fat is the goal of many dancers.
- Dancers usually do not want to build big muscular bodies.
- Instead they emphasize on flexibility, stretching and activities that burn fat.
- BUT: The used techniques and nutritional behaviours of most dancers are not efficient and healthy to reach their goal.

TECHNIQUE REQUIREMENTS

- Flexibility is typically emphasized over muscular strength.
- Depending on the style, the dancing requires a minimal set of movements that must be mastered in order to progress.
- Movements get more complicated as the dancer improves. The dancers repeat a certain move set over and over again which leads to chronically overused muscles.
- Over time they create an imbalance of strong and weak muscle groups.
- The ability to improve the dancing techniques depends on many factors (age, experience, strength etc.)

NUTRITION

- Dance lives in the anaerobic spectrum of metabolic activity.
- To keep up the energy while dancing the body requires glycogen, which mainly comes from carbohydrates and fat.
- Many dancers try to avoid these foods to stay aesthetic.
- Tight performance schedules, as well as lifestyle choices tend to lead to poor nutritional decisions and habits.
- The amount of calories consumed should equal the amount of calories spent while dancing PLUS the amount required for recovery PLUS the amount required for homeostasis.
- There is no estimated amount of calories recommended for a dancer. Depending on the training and how many hours the dancer is performing this number can vary heavily from day to day and dancer to dancer.

## *COMMON DANCE RELATED PROBLEMS*

OVERTRAINING

- Overtraining results after a high volume or high intensity training period without adequate recovery. This happens when the body is not given enough time to adapt from the stress stimulus applied by the training.
- Overtraining results in sleep disruption, chronic pain, mood swings, elevated heart rate and other abnormalities that are similar to a severe depression.
- Once overtraining is diagnosed, one has to act immediately, as longer periods of overtraining require longer periods of recovery.

INJURIES

- Dancing means stress for the body, especially the joints.
- If excessive physical stress occurs on already fragile bone tissue, it could explain why there is such a high incidence of serious skeletal injuries in both dancers and athletes.
- The most common injuries are due to overuse of the joints, involving the feet, lower legs and the knees. (Ankle Sprain, Shin Splints, Knee Pain etc.)
- Such problems are usually associated with technical errors... However, other less obvious factors may include bad nutrition leading to osteoporosis and stress fractures.
- Once an injury occurs dancers often try to dance their way back into shape but this is not an effective rehabilitation tool.

Strength training to improve the musculoskeletal system is both a prevention and the treatment for the majority of dance related injuries and aliments.

- Therapists often misunderstand this concept. They regard the injury itself as the stressor and fail to realize that:
    1. The stress of injury has already been adapted to
    2. The subsequent lack of training stimulus is a stress that has likewise been adapted to
    3. The rehabilitation stress must be intense enough to produce the stress / recovery / adaption response that took the athlete to his previous level of performance

The rehabilitation must cause enough stress that the body will adapt plus a little more. Mistaking the stress of the injury as something that must rest and heal for a bit longer is a failure to understand the fundamental process that govern performance.

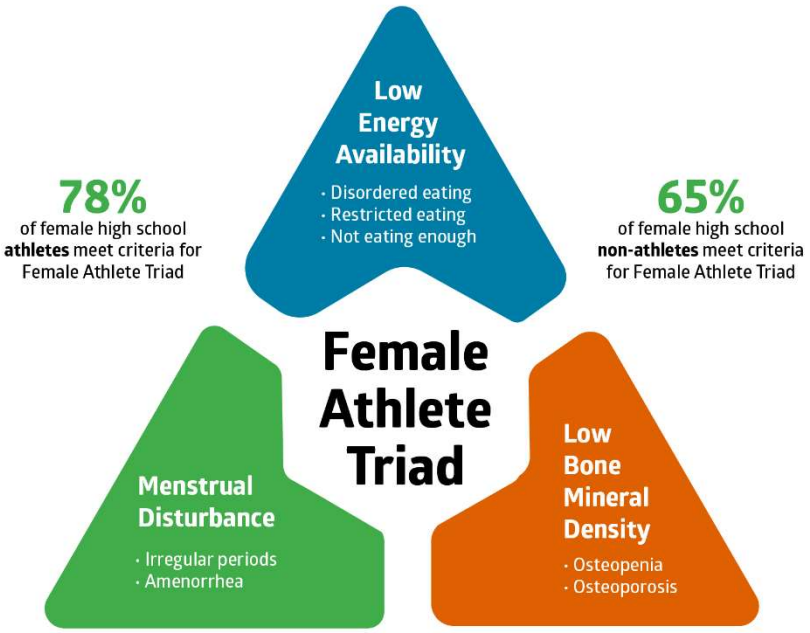
## *THE YOUNG FEMALE DANCER*

(The vulnerable population)

Due to the following points young female dancers belong to the highest risk group related to dance specific injuries and aliments.

- Extreme pressure to meet both aesthetic and technical demands.
- Female hormonal profile and physiology predispose them to injury.
- In order to achieve the desired figure, dancers often restrict their caloric intake or engage in abnormal eating behaviours.
- Poor nutrition, dance schedule and lifestyle habits lead to poor health.

THE FEMALE ATHLETE TRIAD




LOW ENERGY:

- Female dancers often restrict their energy intake to less than 1300 kcal per day.
- Eating disorders, such as anorexia and bulimia, are common.
- **Especially professional and semi-professional dancers are at great risk of suffering from eating disorders, as expectations for the dancer to achieve established body-shape norms force them to use up extreme methods.**
- Insufficient caloric intake, not enough recovery and homeostasis lead to low energy levels.

BONE LOSS AND OSTEOPOROSIS:

- Hormones regulate the growth and absorption of bones.
- Hormones are created from protein, fat and micronutrients.
- If the body is nutritionally deficient, it can not create the hormones it needs.
- Alarmingly, an increasing number of young, physically active, females have also been identified with symptoms of premature osteoporosis. Abnormally low bone densities have been reported for dancers and athletes. **In some cases, active young amenorrheic females may have skeletons that exhibit features typical of that of 50-year-old post-menopausal females.**
- **"The significance of weight training for maintaining a healthy skeleton has been widely appreciated."** (L. Myszkewycz and Y. Koutedakis, «Injuries, Amenorrhea and Osteoporosis in Active Females, 2011»)

MENSTRUAL DISTURBANCES AND AMENORRHEA:

- The menstrual cycle is governed by hormones.
- If the body is nutritionally deficient it will prioritize homeostasis and survival over other functions, such as menses.
- One reason for menstrual disturbances is «energy drain» caused by the intense physical activity, which inevitably results in decreased bodyfat.
- Also, the volume of physical activity seems to have an influence on amenorrhea. It turns out secondary amenorrhea is much more common in females participating in endurance- type training, compared to females participating in strength training programs.
- **Calorie restriction influences amenorrhea too. The more sever the calorie restriction, the greater the risk of amenorrhea.**

## *Strength Training: The Solution:*

- The energy level will increase with building strength and proper nutrition which is crucial for progress, recovery and homeostasis.
- The bone density will improve in order to adapt to the training stimulus
- A dancer's body is rarely subjected to more than their own body weight. Additional weights ensure that the dancer´s body can handle its own weight plus a factor of safety
- The bones are what ultimately supports the weight on the bar.
- **"Bone is living, stress-responsive tissue, just like muscle, ligament, tendon, skin, nerve and brain. It adapts to stress just like any other tissue and becomes denser and harder in response to heavier weight."** (Mark Rippetoe, «Starting Strength: Basic Barbell Training», 2011)

- Proper nutrition is crucial for a healthy hormonal profile for activity, recovery and homeostasis.
- **The average female is protein, iron and calcium deficient. All of these may affect health and performance. Trying to reduce fat intake most woman have managed to reduce their protein intake to levels below that which will support training and recovery.**
- Protein intake for female athletes should follow the same guidelines used for men – 2 grams per kg of bodyweight per day.
- Low iron stores can affect metabolism and oxygen transport, leading to a perception of chronic low energy or fatigue.
- Low calcium intakes predispose every age group to lower bone density. Virtually every study examining weight training with osteoporotic women shows dramatic improvement in bone density. Adequate calcium is needed to allow this adaption to occur.

# *Stress, Recovery and Adaption*

## *WHAT IS STRESS?*

- Stress is defined as an external load or stimulus that causes the body to react in some way.
- Examples include weights, food, temperature, etc.
- The body has three courses of action when it encounters stress:
  1. Ignore or resist – The stress was not significant enough to disrupt homeostasis or the body's coping mechanisms; e.g. no change
  2. Adapt – The stress disrupted homeostasis and the body compensates by increasing its coping mechanisms; e.g. increase in strength, skin tan
  3. Failure – The stress overwhelmed the body's coping mechanisms; e.g. overtraining, sun burn

«Training is predicated on the process of applying physical stress, recovering from that stress, and thereby adapting to the stress so that the process of life may continue under conditions that include the applied stress… "**Training stress needs to be relevant to the performance being trained for to elicit an adaption that improves this particular performance."** (Mark Rippetoe, Practical Programming for Strength Training, 2013)

## *WHAT IS RECOVERY?*

- Recovery is the body's process returning to homeostasis following the application of stress.
- The physiology of recovery is the same for everybody; male, female, young or old...
- Genetics only have a minimal effect on recovery.
- **Recovery is most affected by sleep, nutrition, caloric intake, hydration and periodization; all are aspects in the dancer's control.**

«The body responds to the training stress through the modulation of gene activity, changes in the hormone production, and increases in structural and metabolic proteins, and the accumulated effects of these processes are known as recovery. **"In essence the body is attempting to ensure survival by equipping itself ti withstand a repeated exposure to the stress. The effects of the stress produce a group of reactions specific to that stressor, and recovery from the stress will be specific as well. In the context of training, performance increases."** (Mark Rippetoe, Practical Programming for Strength Training, 2013)

## *WHAT IS ADAPTION?*

- The body adapts to specific stress it is subjected to by changing its physical characteristics; muscles get stronger, bones increase in density.

«After a training session, performance abilities will recover to normal and then performance ability will exceed the pre-stress level. **"This supercompensation, the process by which the body readies itself for a potentially greater stress than the one for which it was already prepared, and which it has already successfully accomplished."** (Mark Rippetoe, Practical Programming for Strength Training, 2013)

# *HOW TO START?*

## *WHY BARBELLS?*

- Barbells allow the body to move naturally, using its full range of motion.
- Except for some special cases we want to stick to free weights and compound movements. **The human body functions as a complete system – it works that way, and it likes to be trained that way.**
- Exercises that only use one joint, and that usually require machines to do, are non-functional in the sense that they do not follow a normal human movement pattern. They also quite often predispose the joint to overuse injuries.
- For an exercise to be useful in a sport, it must utilize the same muscles and the same type of neurological activation pattern as that sport. A sport such as dance requires the use of all the muscles in the body because force is generated against the ground by the hips and legs, transmitted up the trunk, through the arms and shoulders.
- We want to choose exercises that train a lot of muscles through a long range of motion. We want stabilizers to help out and other muscles to take over at some point. **We are training for strength, to increase the force we produce in a big, general movement pattern.**
- **Full range of motion exercises ensure that strength is developed in every position in which the joints can operate.**
- **The only problem with barbell training is that the vast, overwhelming majority of people don´t know how to do it correctly.**

## *ADDITIONAL CONSIDERATIONS*

- **Dancers will gain mass and body weight, but will not «bulk up»; strength training is NOT bodybuilding.**
- Muscles get stronger by increasing the number of fibers that help with the contraction and not by gaining volume (additional fibers).
- Motor unit recruitment – more efficient use of the existing fibers

*ADDITIONAL READING*

# Performance and Fitness Parameters Following 3-months of Aerobic and Strength-Training in Modern Dance Students

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The authors of the introductory chapter of this bulletin began their contribution by asking a few questions which are directly relevant to the current essay: "Can off-studio training be a tool for enhancing elements of dance performance? Are existing dance techniques and methodologies not adequate to serve the needs of today's aspiring dancer? Do dancers need supplementary fitness training?

These questions stem from the fact that although dance medicine and science have been very active in producing valuable data on elements of dance training 1 and overtraining 2,3, fitness 4, injuries 5 and/or health 6,7, research on factors that could potentially affect dance performance has been rather limited. This is partly because, unlike most physiological-biological measurements associated with, say, physical fitness or health which are based on objective procedures, assessments of dance performance largely remain a subjective exercise. Nevertheless, a common characteristic of all dance forms is that they place great emphasis on quality, execution and vocabulary of movement.

In an attempt to provide some answers for the aforementioned questions, our team assessed the effects of a 12-week aerobic and muscular strength training programme on selected dance performance and fitness related parameters in modern dance students. The sample consisted of men and women students of a modern dance school, who were randomly assigned into exercise and control groups. The adopted instruments included anthropometry (height, body mass, and sum of skinfolds), flexibility test, treadmill ergometry, leg strength assessments, and a specially designed test designed to evaluate technique levels. The latter consisted of two pairs of concentric circles (60 and 70 cm and 55 and 65 cm in diameter for males and females, respectively) drawn on the studio's floor. Dancers were required to perform with reference to the circles' center (starting point); 'traveling' away from them followed by the reverse movement, i.e., 'returns' towards the center of the circles. Failure to do so was penalized with point deduction.

Aerobic training contained 20-40 minutes swimming, jogging, and/or cycling, two to three times a week. During sessions, the work intensity was equivalent to 70-75% of the age-related maximal heart rate (age related maximal heart rate = 220- age). The strength training programme also lasted for 12 weeks with up to three 50-minute sessions per week using free weight exercises for both upper and lower body. During the first two weeks, exercises were of low resistance lifts (<70% of one-repetition-maximum, 1-RM) but with high repetitions. The principle of high resistance (>70% of 1-RM) with a low number of repetitions was adopted for the remaining period during which resistance increased by 15-20%. For this period, a typical session consisted of five to six sets of three to four exercises each, with up to eight repetitions in each exercise. A rest period of about four minutes was allowed between exercises in each test and between sets.

Prior to and just after the 12-week strength training period, during which all volunteers maintained their usual nutritional and lifestyle habits, they were subjected to the aforementioned assessments. The main findings were as follows: a) our 3-months aerobic and strength training programme revealed positive effects on selected dance performance and fitness related parameters, b) aerobic capacity and leg strength improvements do not hinder dance performance as examined in this study, and c) the dance-only approach does not provide enough scope for physical fitness enhancements. In other words, supplementary exercise training significantly increased aspects of dance performance with concomitant increases in selected fitness related parameters in modern dance students.

As mentioned above, the multitude of publications in dance is in sharp contrast with the limited data regarding associations between technical/artistic components of dance and fitness exercise training. However, given that the aforesaid training programme revealed significant improvements in the key fitness parameters of aerobic capacity, muscular strength and flexibility, that have been previously linked to better oxygen transport facilities and enhanced neuromuscular functions which, in turn, affect qualitative elements of physical performance through reduced fatigue and injury rates, it is tempting to suggest a possible association between technical/artistic components of dance and fitness exercise-training in the studied cohort. This is in line with another piece of work where a supplemental aerobic and strength training programme compared against artistic proficiency in members of a touring ballet company; those dancers who participated in the intervention programme significantly improved their artistic marks compared to their controls.

A widely acceptable reason for introducing supplemental fitness training to dancers is the very nature of this form of art. It has been suggested that most dance activities do not provide adequate stimuli for physical fitness adaptations, as the low training loads during classes may inhibit typical adaptations seen in other athletes. Given that such physical fitness adaptations to training are intensity dependent, it may well explain why dancers generally reveal lower aerobic, anaerobic or muscular strength levels and higher body fat percentage than other athletes.

Another reason might be the deleterious effects of the recent technological advances on activity levels in general. Indeed, although heavy daily exercise has been a necessary requirement for survival in the earlier history of humans, in modern, industrialized countries, the demand for physical activity is in constant decline. According to the World Health Organisation, more than 80% of the world's adolescent population is insufficiently physically active, which means that the likelihood that young dancers in pre-professional (school) training to come from a pool of relatively unfit individuals is pretty high. Therefore, supplemental conditioning should be incorporated into a dancers' training paradigm to optimize performance.

It is not though just dance performance that acquires the benefits of supplemental fitness training. Health benefits such as reduced body fat, increased basal metabolic rate, decreased blood pressure, improved blood lipid profiles, glucose tolerance, and insulin sensitivity, improved functional capacity, and relieved lower back pain could also be listed.

**In conclusion, it becomes increasingly necessary for the scientific and medical community to explain to dancers – and their teachers – that high-level performance goes beyond the execution of steps. There is enough evidence to support the notion that appropriately designed supplemental fitness training constitutes a safe way to optimize dance performance and maintain health. Significantly, no known data support the fear of many in the dance profession that fitness improvements – such as increases in muscular strength levels – could diminish elements of aesthetics in either male or female dancers.**

# Do Fitter Dancers Dance "Better"? The Effects of Supplementary Fitness Training in Contemporary Dance

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Within the world of dance medicine and science there is an ever increasing research interest towards the benefits of increased physical fitness levels in relation to both performance and injury status. Studies have observed "statistical associations" between specific physical fitness components, such as muscular power and endurance and qualitative aspects of "dance performance", as well as injury severity. Nevertheless, these observed "associations" do not imply causality, meaning that only carefully designed intervention studies, such as the one herein, will ensure that the observed "effects" (i.e. dancing better or suffering less injury) are consequences of the increased levels of muscular fitness. The question is: When do we use muscular power and endurance in contemporary dance? Angioi and colleagues report that simple examples of exploitation of upper body muscular endurance are happening during partner work when repeatedly lifting and supporting other dancers and/or in transitory movements from floor to stand and vice versa. Lower body muscular power, on the other hand, is necessary to develop elevation during the take-off phase of any type of jump.

In this study, we designed a combined circuit and vibration training aimed to specifically stress the lower body ability to produce power and the upper body muscular endurance as well as the general stamina (aerobic fitness). The overall aim was to ascertain if increased physical fitness levels were reflected into the aesthetic competence level of 24 female contemporary dancers (professionals and students). Each dancer was either randomly assigned to the combined circuit/vibration training group (in addition to usual dance training) for 6 weeks (intervention group) or the control group and simply carried on with the usual dance training (control group). All 24 dancers were tested for initial levels of lower body muscular power, upper body muscular endurance and aerobic capacity, via some commonly used tests including standing vertical jump, numbers of press-ups performed in one minute and a dance-specific aerobic fitness test. All dancers also undertook an "aesthetic competence" test, which was developed to objectively score 7 aspects of contemporary performance (between 1 to 10), including control of movement; spatial skills; accuracy of movement; technique; dynamics, timing, and rhythmical accuracy; performance qualities; overall performance.

12 dancers undertook the supervised fitness training; this was organized twice a week and each training session lasted approximately 1 hour and included circuit training (CT) and whole-body vibration training (WBV). The CT training consisted of lower and upper body exercises, organized in 10 stations. The 10 exercises included: jumps with feet in parallel position (using a jumping rope), press-ups, bicep curls, triceps extension (with free weights of 0.5 kg each), single leg squat, squats-jumps, relevés in first position, grand-plie in second position, chest press exercises (with free weights of 0.5 kg each), and plank. Dancers had to exercise for 30 sec in each station, with 10 sec of transitory time between one station and the other, making the total time for each circuit of 6 min 50 sec (including the rest between each station). Dancers had to complete four circuits. The WBV training protocol used six dance-specific static positions on a vibration platform (frequency set at 35 Hz and amplitude at 2.5 mm) including:1) plié with feet in first position.; 2) plank (elbow flexed on the floor and feet on platform); 3) lunge (right and left leg); 4) press up, 90° bend at the elbows; 5) feet in relevé with knees slightly bent; 6) hamstring position, bent over at the waist, with knees slightly bent and hamstrings tensed. The training consisted of three sets, lasting 40 seconds with 2 minutes rest between each set.

While results of initial tests revealed that all 24 dancers had similar levels of muscular power, endurance, aerobic– aesthetic competence test, we observed some differences following the 6 weeks of supplementary fitness training. More specifically, only the dancers who undertook the supplementary training showed increased levels of muscular power, endurance, aerobic capacity as well as scoring higher results for the performance test.The observed increased aerobic levels were attributed to the circuit training, while the increase in muscular power and endurance were a result of the combined CT and WBV training. The latter, in particular, enhances muscular power by rapid concentric and eccentric contractions potentiating the neuromuscular system of the dancer. The fact that dancers who did not undertake the fitness training did not improve the studied fitness components, suggests that dance training is not sufficient enough to overload the body enough to produce physiological adaptations that will enhance each individual fitness component. The other important aspect of the present study is the evaluation of the aesthetic competence of the dancers. The results revealed that dancers who improved their fitness levels scored significantly higher in the aesthetic competence, hence “dancing better” is linked to physical fitness. As previously suggested, this is because dancers’ use their body as an instrument of expression and the most common technical skills/movements (jumps, transitory movements etc.) used in contemporary dance require enhanced fitness levels as well as artistry.

**What are the implications of such findings for dance teachers? Firstly, the present study contributes to the open debate whether dancers would further benefit from enhanced physical fitness levels equally to similar athletes. Secondly, incorporating supplementary training will help bridge the observed fitness gap between performance preparation (class and rehearsals) and performance periods. Nevertheless, the incorporation of supplemental training into the dancer's schedule must take into account the present workload, which can involve 6 to 8 hrs/day of exercise at varying intensities already. Training sessions need to be timetabled at the end of the day, to prevent fatigue interfering with the high skill elements of dance. The selection of exercises can be tailored to the choreographic demands, if these are known in advance. The use of WBV training in particular has been shown to provide adaptation of the muscular system with minimal time cost, which is a vital advantage when the daily work time is controlled by unions and the majority of time is focused on artistic training. In conclusion, a 6-week supplemental CT and WBV training had a significantly beneficial effect on both physical fitness indices and aesthetic competency for skilled contemporary dancers.**