Dance Stronger: Strength Training and Nutrition for Today's Dancers

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Introduction

Since the beginning of history, dance has been an art form and a cultural tradition passed down from one generation of dancers to the next. Sometimes this is done through imitation of the teacher, and sometimes the teacher provides a more in depth explanation of how the steps should be executed, but always the emphasis is on passing on the valuable lessons and training that the teacher themselves inherited from their own teachers. This traditional passing of knowledge from one generation of dancers to the next is a beautiful and valuable thing; however, with the range of material that today's dancers must be able to perform and the ever increasing level of skill required to succeed in the current dance world, the traditional knowledge alone is not enough to prepare dancers with the training they need. Fortunately, in the past few decades, research in the field of sports science and training has advanced greatly and can fill the gaps left by traditional dance training, as long as dancers and teachers are willing to learn and utilize it. This new knowledge can help to reduce injury rates and help dancers to both feel and perform their best, and will in no way negatively affect traditional dance training. Unfortunately, this supplemental knowledge is often ignored or, even worse, misunderstood by dancers, dance teachers, and dance company directors, which can lead to misinformed and even dangerous practices. All this is not to say that current dance training is wrong, but simply to emphasize the importance of expanding

on traditional practices and enhancing them with modern scientific knowledge and understanding of the human body as it pertains to training. The purpose of this paper is to present the current research on strength training as cross training for dancers and on nutrition for dancers, as well as to provide concrete guidance in both areas for how to implement this research into a dancer's daily life.

Strength Training for Dancers

Ask most ballet dancers what they do for cross training – for our purposes defined as any training completed outside of a dancer's regular dance classes and rehearsals – and the answers will most likely be the familiar ones of Pilates and yoga classes, and the gym, which in this case is code for long cardio sessions, possibly followed by an abdominal workout. These self-designed programs are generally based on teachers' suggestions and personal interest, rather than any regulated plan, and unfortunately are often nothing more than a waste of the dancer's time and energy when it comes to increasing strength and dancing ability, and have received little scientific validation (Twitchett 7).

Contrast this with the carefully designed cross training programs typically followed by athletes, consisting of a balance of strength training, cardio, and agility work interspersed with planned periods of rest. These plans are typically designed and overseen by a coach or trainer who can be responsive to the individual needs of each athlete.

The difference is clear, but the reason behind it is not. The athletic demands of dance and sport are similar in intensity and requirements; aerobic ability, muscular strength and powers,

and agility. Why then is the training for each treated so differently? Dancers are rarely considered by those outside the dance field to be athletes, but the level and intensity of their training and performance can accurately qualify them as such. Research into dance and sports science has shown how valuable strength training can be for dancers, and it appears that the main barriers holding dancers back from embracing the knowledge utilized by sports scientists and athletes are the longstanding traditions in dance training passed down from teacher to teacher; misinformation about the effects and benefits of strength training coming from teachers, artistic leadership, and peers in the dance community; and lack of education on the scientifically backed fitness practices that could save the health and careers of so many dancers.

While there has been minimal research done into strength training as cross-training for dancers, and many gaps in the available knowledge exist, the research that has been done shows similar conclusions between studies. This research has primarily focused on three areas; what the athletic requirements are for dancers, how those requirements are or are not met by traditional dance training, and if/how strength training can help to prevent injuries in the dance population. The intent of this paper is to summarize the most relevant scientific literature, and to take the next step by translating that research into a practical guide that can be used by dancers, and the teachers and company directors guiding and supporting them.

Athletic Requirements for Dance

The athletic requirements for dance are many, as it is a highly intensive activity. In a 2004 paper, Koutedakis et al. write that “As in most sports, dance fitness depends on the individuals’ ability to work under aerobic and anaerobic conditions, and on their capacity to develop high levels of muscle tension, i.e., muscle strength. Joint mobility/muscle flexibility and body

composition are also important parts of dance fitness." In simple terms this means that dancers must have great cardiovascular ability, strong muscles, flexibility, and, traditionally, a low body fat percentage (653).

Multiple studies, including those by Twitchett and Koutedakis, have found that traditional dance classes, particularly ballet classes, the style in which most research has been conducted, as well as typical cross training activities such as Pilates and Yoga, which have received little scientific validation, fail to fully prepare dancers for any of these requirements (Twitchett 1, Koutedakis 651). The possible exception to this is flexibility, which dancers tend to possess in abundance, which creates its own problems as, in the absence of strength, excessive flexibility can also lead to injury (Knight 1).

Dance has been described as an "intermittent" activity in its requirements, meaning that it primarily consists of relatively brief periods requiring high energy, followed by periods requiring less energy, but more precision and skill (Twitchett 1). Take, for example, a ballet variation; typically, there will be a section requiring high energy such as jumps, followed by a section of detail and skill, such as turns. This can also be seen in the structure of a dance class, both at barre and in center, where exercises are short, but require lots of energy to perform. These are typically under a minute in length, interspersed by periods of feedback and instruction from the teacher. Exercise science tells us that improvements in cardiovascular ability take place only during exercise intervals of 20 minutes or longer, vastly more time than is ever spent constantly moving in most dance classes (Koutedakis 653). Dance performances, in contrast, frequently require longer periods of sustained activity, with many pieces requiring a dancer to be on stage for as long as 30 minutes at a time, although that entire time may not be spent dancing.

This theory that performance requires greater stamina than class is supported by studies that show slightly improved cardiovascular ability in professional dancers who are regularly performing than in students, which researchers have credited to rehearsals and performances themselves, rather than any difference in training (Koutedakis 652). Even professional dancers, however, have been shown to have lower maximal oxygen (VO2max) values (a scientific measure of cardiovascular ability) compared with other athletes (Koutedakis 652).

All of this means that dance classes alone are likely not enough to make the cardiovascular changes in dancers that could benefit them on stage. Not only does this make it difficult for dancers to get through a performance, but low cardiorespiratory endurance has been found to lead to an increased risk of injury (Russell 202). Improved cardiovascular ability would lessen that injury risk, improve performance, and also make the intermittent activity of classes far easier for dancers, allowing them to focus on their technique and execution of the exercise, rather than simply getting through it. Additionally, in a study of professional ballet dancers, those who engaged in additional fitness training as well as their dance classes showed a decrease in psychological stress, as well as an increase in maximal oxygen (VO2max) values (Russell 203).

The underdevelopment of muscular strength in dance technique classes has also been correlated with an increased risk for injury. The theory that dance classes alone do not provide adequate muscle strengthening was proven by a study that compared strength increases in dancers engaging in a supplemental training program to a control group taking only their usual classes (Koutedakis 654). This showed that dance classes alone do not dramatically improve muscle strength, and an additional training program can therefore be beneficial. In a 2009 paper, Twitchett wrote that, “Potentially, the dancers' neglected physical foundations, slightly offset by their highly developed economy of movement, leave them susceptible to fatigue. This in turn has

an effect on skill, causing poor alignment, especially during landing and lifting, and thereby exposing the body to inappropriate shear and rotational forces, increasing risk of injury. This differentiates classical ballet from sports in which athletes have a good reserve of physical fitness to 'fall back on' should problems with skill arise" (7). Given that up to 85% of professional dancers have been found to get injured each year, a supplemental strength training program that could help reduce injury rates could positively impact a majority of dancers (Twitchett 7). Not only would a decrease in injury allow dancers to continue dancing and remain pain-free, but also reduce the need for last-minute casting changes, limiting the related stress on both dancers and management. This is also extremely cost-effective, compared to the price of treating injuries; including X-rays, MRIs, suguries, physical therapy, etc.

Research has found that dancers have a range of motion and strength at the hip and ankle joints that is greater than average, but weaknesses in the upper body, torso, hamstrings, and quadriceps. Specifically, it has been found that "poor core stability has been identified as a risk factor for upper and lower extremity injury, and inadequate neuromuscular control in the trunk has been specifically associated with increased athletic knee injuries in females" (Russell 203). Lower thigh-strength levels have also been correlated with increased risk of injury (Koutedakis 655). Another high injury risk that has been found is the existence of both strong and weak muscles in the same part of the body, especially in agonist-antagonist muscle groups (muscles that work opposite to each other, such as the biceps and triceps) (Koutedakis 655). This inequality in muscle strength also increases the severity of an injury when it occurs (Koutedakis 655). This finding shows the importance of training all muscle groups, as well as the value of strength training for the antagonistic muscles to those commonly used and strengthened in dance, in order to limit potential injury. It has been found that doing resistance training in addition to

dance classes results not only in increased strength, but also improved dance performance (Twitchett 7). This means that dancers engaging in a strength training program could see both a decrease in injuries and an increase in dancing ability.

Given this information, it is clear that the important question is no longer if dancers should be incorporating strength training into their training plans, but rather what, specifically, should they be doing?

Research has found that dancers' greatest weaknesses lie in their upper body, torso, hamstrings, and quadriceps, implying that these muscle groups could benefit the most from additional strength training. This implication was confirmed in a study which found that, "supplemental resistance training for hamstrings and quadriceps can lead to improvements in leg strength and dance performance without interfering with key artistic and physical performance requirements in male and female dancers" (Twitchett 4). Additionally, Russell's previously discussed finding on the correlation between poor core stability and injury to both the upper and lower extremities shows that core strength should also be a vital part of any dancer's training (203). In addition to strength training, cardiovascular training is also immensely beneficial. It should be noted however, that only performing cardio training is not enough as it will not address any of the concerns pertaining to lack of strength.

Dancers already tend to have highly rigorous schedules due to their daily classes and rehearsals, and so adding additional time for strength training is a concern, as the goal of an additional training program is to support the dancer's ability to dance and perform, not cause them to burn out. Twitchett writes that adding "additional supplemental training to their [dancers'] already busy schedules is impractical and would possibly increase the injury rate and occurrence of overtraining." However, she proposes an alternative, writing that, "The

substitution of 2 to 3 dance classes a week with physical conditioning classes would have a beneficial effect on the dancers underlying physical fitness without interfering or causing a deterioration of skill; there should be enough skill reinforcement within 2 classes a week, rehearsals, and performances to maintain skill levels" (7). While this idea of fewer dance classes and designated strength training time is currently something of a remote concept in the dance world, it is something that should be seriously considered moving into the future, especially if additional research can be done to back its efficacy.

Following Twittchett's recommendation of 2-3 days of strength training per week during a dancer's season or semester, depending on their current status, and the research on key muscle groups for dancers to strengthen, a workout plan could look like the following:

Day 1- Upper Body "Pull"

- Assisted pull ups and chin ups, 2-4 sets
- Lat pull downs, 2-4 sets
- Cable face pulls, 2-4 sets
- Seated row, 2-4 sets
- Single arm rows, 2-4 sets
- Standing biceps curls, 2-4 sets
- Hammer curls, 2-4 sets

Day 2- Upper Body “Push”

- Super Set (perform two exercises back-to-back, then rest and repeat both)
    - Overhead press, 2-4 sets
    - Lateral raises, 2-4 sets
- Super Set
    - Bench press, 2-4 sets
    - Overhead triceps extension, 2-4 sets
- Chest press machine, 2-4 sets
- Triceps dips assisted machine, 2-4 sets
- Understand triceps extensions, 2-4 sets
- Upright cable pulls, 2-4 sets
- Front dumbbell raise, 2-4 sets

Day 3- Lower Body

- Leg press, 2-4 sets
- Leg extension, 2-4 sets
- Hamstring curls, 2-4 sets
- Adductor, 2-4 sets
- Heel elevated narrow stance goblet squats, 2-4 sets
- Single leg dumbbell squats, 2-4 sets
- Stretch

Each workout should be preceded by a 5-10 minute warm up and followed by 30-45 minutes of a dancer's preferred cardio (elliptical, stationary bike, rowing machine, treadmill, etc.). Additional time spent performing cardio will not provide additional cardiovascular benefits, and can slow muscle gain (ISSA 308). During cardio activities, dancers should aim for an intensity level of 55-85% of their maximal heart rate, which can be calculated by subtracting their age from 220 (ISSA 309, 310). Performing the strength training exercises with heavier weights and fewers repetitions (reps) will be the most beneficial for growing muscles, while performing the exercises with lighter weights and more reps will develop greater muscular endurance. Depending on a dancers' current needs, both options can be valuable.

Another important, and often ignored, factor that should be included in a dancer's training plan is rest. Koutedakis writes that "The pressures for more and better performances have transformed preparation for successful dance to virtually a year-round endeavor. As a result, an increased number of dancers also experience the symptoms of the recently described 'burnout' or 'overtraining' in dancers" (657). He also writes that, "A 3- to 4-week period of rest after the end of a demanding season has been linked to increases in most fitness-related parameters in both dancers and athletes. It is possible that overtraining and the associated fatigue before the resting period may have contributed to these findings" (Koutedakis 657). Symptoms of overtraining may include prolonged general fatigue, increases in tension, depression, anger or confusion, an inability to relax, poor-quality sleep, a lack of energy, decreased motivation, moodiness, and the inability to get satisfaction from things that were once enjoyable (Goolsby).

Dancers should work to prevent overtraining by ensuring they have at least one day a week fully off from dance or other physical activity, and allowing themselves periods of rest after a dance season/semester, as well as aiming for adequate sleep during the season/semester (Russell 204).

By implementing a strength training program and adequate rest into their cross training routine, dancers can reduce their likelihood of severe injury, work on targeted strengthening for their personal weaknesses, recover from periods of intense dancing more effectively, reduce the likelihood of burnout, and perform at their best and strongest. All of this is to the benefit of the dancers' physical and mental health, as well as the benefit of their faculty and directors, who will have to manage fewer casting changes due to injured dancers.

Nutrition for Dancers

Turning next to the importance of proper nutrition, there are many benefits to utilizing the scientific knowledge on sports nutrition for dancers. All dancers know from a young age that they are supposed to eat healthy, but, as in the general population, there is a lot of confusion as to what that actually means. To some it means cutting out sugar, or carbs, or going on a low-fat diet. To some it means eating vegan or vegetarian. Oftentimes "eating healthy" is coded language for not eating too much in the aim of controlling body weight in the aesthetic art form which is dance, a practice which far too often leads to eating disorders and other unhealthy nutrition practices. So what is actual healthy eating for dancers? Comparatively little research has been done on this topic, but there is an abundance of information pertaining to athletics, which can be applied to dance as well, given that both dancers and athletes are highly active individuals with

specific, performance and aesthetic-driven goals. As in the exercise portion of this paper, the intent here is to examine truly sustainable and healthy nutrition practices for dancers, based on the strongest dance and sports science, examine how these can be practically applied, and also to examine how dance teachers and company leadership can help develop and support these practices in their dancers.

Before examining these healthy practices however, let's examine why they are so desperately needed in the dance world.

Disordered Eating

Far too many dancers suffer from some form of disordered eating at some point in their careers, or know another dancer who has, with many finding that the only way to recover is to quit dancing altogether. Disordered eating affects both a dancer's physical and mental health and hinders their ability to succeed in the challenging field that is dance. Far too frequently these issues arise due to pressure from teachers, company and rehearsal directors, and other leadership figures in the dance world, who can hold incredibly high, even unhealthy, standards for their dancers and provide them with little to no guidance as to how to achieve those goals.

A study done on dance students in the UK, found that, as expected, "research typically reports higher rates of disordered eating among dancers than non-dancers" (Nordin-Bates 211). Contrary to the popular belief that female dancers are primarily affected, however, they found that men and women in dance appear to suffer from eating disorders at relatively similar rates (Nordin-Bates 224). Other studies examining rates of eating disorders in athletes have found rates from 1% to 62% specifically in female athletes, with higher rates in sports that are highly

aesthetic-driven, such as dance (Javed 4). These studies show that not only are eating disorders likely in dancers, but they affect everyone.

In October of 2020, former Miami City Ballet dancer Kathryn Morgan, a long-time YouTuber with a reputation for being totally honest with her followers, posted a video on YouTube and Instagram, diving into topics such as mental health and eating disorders that often go undiscussed in the dance community. he shared her experience with that company's leadership and casting decisions. Throughout her single season with the company, for which she was hired as a soloist, she was continuously sidelined and removed from casting with company leadership expressing that she wouldn't "represent the company well" due to the fact that she "didn't look like a ballerina," despite the fact that she was in better shape than when she was hired, and is by no means fat at only a size 2 (Morgan). Kathryn's story became the catalyst for other dancers from multiple companies to speak out and share their own experiences.

Stories were remarkably similar across the board, and even as dancers went on unhealthily restrictive diets they were told that it wasn't enough. Chloe Freytag, another former Miami City Ballet dancer, shared that while she was on such a severe diet that she was "dizzy, weak, and dancing poorly," and had lost about 8 lbs since she was told she needed to lose weight, she was "taken out of ballets because I 'hadn't lost enough weight'" (Freytag). Many dancers turned to other extreme measures as well. Kathryn Morgan wrote that "Once my body was called into question by artistic, I started doing whatever I could to get the weight off. Part of that was not eating, but I also over-did it in other ways. So some days, instead of going to class, I went to my nearby Equinox to do cardio for an hour and sit in the sauna to try and burn off every inch I could. Even looking thinner from one day to the next was important to me...I even hired a personal trainer on my own dime and worked with her when I wasn't rehearsing. I was so

desperate to please the powers at be so I could dance. But I kept all of that to myself out of fear of being judged or ridiculed further...I was so humiliated that I truly couldn't bring myself to be in the building any more than I had to be" (Kathryn Morgan).

The most common quote from dancers who spoke out was some variation of "I hated my body," falling in line with research by the National Dance Alliance which stated that out of 107 female college dancers, 76% of those dancers agreed with the statement, "I think there are pressures to lose weight in dancing" (Oliver 22). This is a tragic sentiment from anyone, much less high-level dancers whose body is their instrument, the thing that enables them to do what they love and pursue their goals.

Equally important to understanding the prevalence of eating disorders is understanding the risks they bring to a dancer's, or anyone's, body. The signs are often harder to catch for male dancers and athletes, but the female athlete triad is frequently used as warning signs for active women. The female athlete triad refers to three, often interrelated, conditions: low energy availability (which may be intentional or unintentional), menstrual dysfunction, and low bone mineral density. It is important to note that experiencing one or two of these three criteria frequently occurs, and is still cause for serious concern and intervention (Javed 2). Studies have found, in fact, that only a small percentage of athletes experience all three conditions (0%-15.9%), but that 2.7%-60% may experience one or two (Javed 3). Additionally, the likelihood of any of the triad conditions is two to three times greater in sports that emphasize aesthetics, such as dance (Javed 3). Research shows that disordered eating in active women, such as dancers, leads to chronic energy insufficiency, clearly an issue in dance, which requires so much energy to perform well (Javed 5). In other words, all three conditions are interrelated and

menstrual dysfunction and low bone mineral density (BMD) may be caused by the primary condition of low energy availability, which comes from not eating enough.

This low energy availability may be either intentional, such as an eating disorder, or unintentional, such as a lack of awareness of fuelling requirements for an increased activity level (Javed 3). When faced with insufficient fuel, the body's response is to do what it can to maintain activity levels and body weight, often at the sacrifice of cellular maintenance, growth and reproductions, as well as brain function, decreased metabolism, and decreased non-exercise activity thermogenesis (NEAT), which includes non-exercise related movements throughout the day such as fidgeting, pacing, etc. (Javed 6 and Trexler 1-3). Unsurprisingly, athletic performance has also been proven to be negatively affected by energy deficits (Javed 9). Current knowledge shows that "energy availability should ideally match, if not slightly exceed, resting energy expenditure (the amount of calories needed to maintain basic body systems and body temperature at rest) in order to allow physiologic processes of the body to continue," not to mention the additional energy required for a highly physical activity such as dancing (Javed 2-3).The body will prioritize movement over other necessary functions, meaning that, while a dancer in low energy availability may be able to continue dancing, though less strongly, as just stated, they will most likely be doing so at the cost of their health.

According to the latest understanding of the female athlete triad, "The skeletal health component of the triad ranges from optimal bone health to osteoporosis" (Javed 4). A 10% reduction in weight may result in a 1% to 2% loss in bone mineral density (BMD) and, while low BMD can occur in energy-deficient athletes that have no menstrual dysfunction, those with dysfunctions such as amenorrhea are more likely to have even lower BMD and increased risk of

injury (Javed 7). One study found a 100% rate of stress fractures occurring in amenorrheic ballet dancers dancing more than 5 hours a day (Javed 7).

When weight is lost, as will typically occur with an energy deficit, metabolically active tissue also decreases, which in turn decreases basal metabolic rate (BMR), or the amount of calories needed to maintain that weight; additionally, fewer calories are needed to bring a lighter body into action (Trexler 3). However, if the energy deficiency, also known as relative energy deficiency syndrome, or RED-S, continues long enough, metabolism may slow even further than would be predicted, as the body tries to maintain its natural weight, and continued weight loss becomes difficult due to these hormonal, cellular, and energetic changes, even with severe caloric restriction and excessive exercise (Trexler 1). It should also be noted that an individual with a seemingly normal body weight can still be suffering from low energy availability (Javed 19). The most evidence-backed way to treat the female athlete triad is through energy restoration (eating more food). However, all these physiological and metabolic changes mean that once an individual stops their diet, weight may be regained rapidly and primarily in the form of fat as the body attempts to restore itself (Trexler 1). Most dancers are uncomfortable with this, and so remain trapped in an unhealthy energetic (caloric) deficit until they become ill, injured, or seek help.

While many dancers may remain thin due to the activity of dancing, the idea that being thin is a requirement for being a dancer and that a dancer's diet should always be designed to promote weight loss is both unfounded and potentially dangerous, as even healthy weight loss plans can veer into orthorexia (an obsession with healthy eating to a dangerous degree). Rather, the focus should be on teaching dancers how to fuel their bodies sufficiently for the intense

amounts of activity they perform and on changing the culture of dance to allow and embrace dancing bodies of all sizes, allowing all dancers to be at the weight that is healthiest for them.

Healthy Nutrition

So what exactly does a healthy nutrition plan for dancers and athletes look like? The biggest difference between general healthy eating and sports (or dance) nutrition is the level of specificity -- fueling to support peak activity rather than fueling simply for balanced nutrition and health. Good sports nutrition is a powerful tool. In their outline on sports nutrition, the American College of Sports Medicine, the American Dietetic Association, and the Dietitians Of Canada write that "Achieving energy balance is essential for the maintenance of lean tissue mass, immune and reproductive function, and optimum athletic performance… With limited energy intake, fat and lean tissue mass will be used by the body for fuel. Loss of muscle results in the loss of strength and endurance. In addition, chronically low energy intake often results in poor nutrient intake, particularly of the micronutrients" (American College of Sports Medicine 2-3). This is the common problem we have been observing in dancers. Sports nutrition solves that problem. While most of the principles of a basic healthy diet also apply to sports nutrition, sports nutrition takes it a step further to consider more specific timing of food and macronutrient goals as well as fluid consumption around activity. Sports nutrition takes into consideration the specific types, such as high-intensity or low intensity, and durations of activity a dancer or athlete is performing and tailors nutrition to suit their needs and goals. Research shows that so long as adequate energy is being consumed from a variety of foods, there are no requirements for vitamin or mineral supplements with exceptions only in rare cases (American College of Sports

Medicine 1). Each part of that variety of food provides macronutrients and micronutrients that play important roles in fuelling an active individual, such as a dancer.

Carbohydrate is the primary fuel source for any activity, and the amount needed depends on the level of activity. Carbohydrate is stored as glycogen within the muscles and liver and is the easiest source to convert into energy. “If the muscles are inadequately fuelled,” writes Renee McGregor, a top sports nutritionist and dietitian from the UK, “it will lead to fatigue, poor performance, and potentially lower your immunity, putting you at greater risk of illness” (McGregor 18). Because glycogen storage is limited, it is important to plan carbohydrate intake around activity schedules to ensure adequate supplies (McGregor 18). In general, carbohydrates should always be consumed prior to activity to ensure enough energy to fuel that activity. Importantly, high-intensity training tends to use around 60g of carbohydrate per hour, therefore, during any period of activity lasting longer than one hour, such as a typical dance class, stores should be refilled with a small snack or drink containing carbohydrate (McGregor 19, 113-114).

There are more than one type of carbohydrate as well, and each has a different place in a dancer’s or athlete’s nutritional plan. Nutrient-dense carbohydrates provide additional nutrients as well as the carbohydrate, and include options such as bread, whole grains (oats, pasta, rice, etc.), starches (potatoes, squash, etc.) fruit, legumes (beans, peas, peanuts, etc.), and dairy products). Nutrient-dense carbohydrates are an important fuel source that should be eaten every day and are absorbed more slowly by the body (McGregor 19). Nutrient-poor carbohydrates provide only carbohydrate, and include options such as sugars (sugar, honey, molasses, etc), and white bread. Nutrient-poor carbohydrates shouldn’t be eaten every day, but may be useful for supplemental carbohydrate during activity, as they are more rapidly absorbed, providing a more immediate source of energy (McGregor 19). High-fat carbohydrates provide high percentages of

fat in addition to carbohydrate, and include options such as pastries, chocolate, chips, etc. These options may still be enjoyed, but more occasionally and not around training as they provide limited nutritional value (McGregor 19).

Because carbohydrate needs are based on activity level, requirements will vary for each dancer, but guidelines are available. The following is a variation on a chart created by Renee McGregor to determine carbohydrate needs.

Exercise Intensity	Example	Carbohydrate Targets for Men	Carbohydrate Targets for Women
Low	Yoga, Pilates, exercising fewer than three times per week	3-5g per kg of bodyweight	2-4g per kg of bodyweight
Moderate	Around one hour of exercise per day	5-7g per kg of bodyweight	3-5g per kg of bodyweight
High	1-3 hours of moderate to high intensity per day	6-10g per kg of bodyweight	5-7g per kg of bodyweight
Very High	4-5 hours of moderate to high intensity per day	8-12g per kg of bodyweight	8g per kg of bodyweight

Looking at this chart from a dancer's perspective, we can see that most days with 1-2 classes and/or rehearsal will be high to very high levels of intensity and even off days in which a dancer might go to the gym, take a yoga class, or even take a casual stroll, will still be considered low to moderate intensity and require adequate fuelling.

Protein is frequently referred to as the building block of the body, and is key for building strong muscles, bones, tendons, skin, and hair. Current knowledge says that protein requirements

are slightly increased in highly active people, such as dancers and athletes, especially for those performing strength training (American College of Sports Medicine 1). As with carbohydrates, timing is also important with consumption of protein, as protein is needed primarily as a response to exercise, rather than as fuel (McGregor 25). Protein, therefore, is a key part of nutrition during the recovery phase after exercise. A general guideline is that active individuals should consume about .25g of protein per kg of body weight, 3-6 times per day, with the number of portions determined by activity level and variety (McGregor 26). Muscle gain can be encouraged by protein consumption on the higher end of this guideline, but more than .25g per kg has no added benefit (McGregor 27). Some research shows that protein consumption up to 25% of daily caloric intake, in combination with strength training, can help to preserve lean body mass and limit the slowing of metabolism during periods of weight loss (Trexler 2).

Fat is also an important part of a sports nutrition plan, as it helps the body to absorb essential nutrients and provide fatty acids that the body alone cannot produce. Like carbohydrates, however, there are different kinds of fats. Unsaturated fats, such as those found in oily fish like salmon, nuts and seeds, avocado, and olive oil, should make up the majority of fat intake. Saturated fats, such as butter, cheese, sausage, as well as trans fats found in processed foods, should be limited to around 20g per day for women and 30g per day for men (McGregor 30). Guidelines for general fat consumption are around 1g per kg of body weight, or about 20%-25% of daily caloric intake (McGregor 30, American College of Sports Medicine 1). Research has found that “Fat intake should not be restricted, because there is no performance benefit in consuming a diet with less than 15% of energy from fat, compared with 20% to 25% of energy from fat… Additionally, there is no scientific basis on which to recommend high-fat diets

to athletes" (American College of Sports Medicine 2). This finding shows that fats, like other macronutrients, should be consumed in moderation; not too little and not too much.

Adequate levels of hydration are also key to peak performance and recovery. Current recommendations are 400 to 600 mL of fluid (10-13 oz) 2–3 hours before exercise, with 150 to 350 mL (6 to 12 oz) of fluid at 15- to 20-minute intervals, beginning at the start of exercise (American College of Sports Medicine 8). As mentioned with carbohydrate, during periods of exercise lasting longer than one hour, sports drinks containing 4%-8% carbohydrate may be useful for replenishing stores (American College of Sports Medicine 8). This can be store-bought or a homemade mixture of 10 oz fruit juice to 8 oz water with a pinch of salt for sodium. Consumption of sodium, both through drinks and snacks such as pickles, cheeses, pretzels, popcorn, and condiments such as soy sauce and ketchup have been found to aid in rehydration by increasing thirst and thereby water intake (American College of Sports Medicine 8-9). While caffeine has often been considered dehydrating, current research shows that 1-3 cups of coffee, 3-6 cups of tea, or the equivalent, will have no negative effects, and can be beneficial if timed well and an individual responds positively (McGregor 40).

Post-exercise recovery nutrition is equally important as fueling before exercise. As mentioned, protein is an important part of that recovery nutrition to build and repair muscle tissue, but recovery fuel must also consist of adequate carbohydrate to replace stores (American College of Sports Medicine 2). Timing is again essential, with requirements to eat within different windows of time for different situations. If a second training session will occur within 24 hours (say a late night rehearsal and an early morning class the next day, or two classes within the same day), recovery food should be eaten within 15-20 minutes of finishing the first activity (McGregor 52). If the next activity session takes place more than 24 hours later, more time can

be taken, as long as recovery food is eaten within two hours of finishing the first activity (McGregor 52). In practical terms for dancers, this means packing lots of snacks to eat throughout the day in between classes and rehearsal in order to continue dancing optimally. The contents of a recovery snack or meal vary based on training intensity. After high-intensity training, the recommendation is 1-1.2g per kg of body weight of carbohydrate with .25g per kg bodyweight of protein repeated throughout the day at 2-3 hour intervals (McGregor 52). After low-intensity training the baseline of .25g per kg of body weight of protein and 3-5g of carbohydrate will be sufficient, as long as it is eaten within the right window of time (McGregor 52-53).

Counting calories or tracking macros is not essential to good sports nutrition; the guidelines for recommended intake focuses more on the specific macronutrient needs than on caloric needs; however, understanding the amount of calories and specific macronutrients required to fuel peak performance can be beneficial to finding energy balance, or reaching more aesthetic-focused goals, in addition to ensuring correct nutrition. This may be especially true for dancers accustomed to a restrictive mindset around food, seeing the scientific data explaining why more food is required can help make dancers more willing to make a change in their nutrition. Due to the high levels of activity that most dancers perform, caloric needs can also be quite high, with current knowledge being that, “the recommended energy intake for sedentary women is 1800 to 2000 calories/day, and an additional 500 to 1000 calories/day is advised for active women. The dietitian and athlete should draft a meal plan based on REE [resting energy expenditure, also known as BMR or basic metabolic rate] and EEE [exercise energy expenditure]” (Javed 19). BMR and EEE can be approximated by use of a fitness tracker, which shows the amount of calories burned throughout the day, although these may not always be

accurate, or with help from a dietician. Additionally, it should be noted that, especially immediately after exercise, athletes, or dancers, "may not sense appetite normally, and the meal plan should be followed by discipline more than by appetite" (Javed 19). This shows the importance of understanding the principles of sports nutrition and having a clear plan to follow, as intuitive eating may be more difficult for highly active individuals. Special care must be taken, however, to ensure that tracking food intake does not become excessive or lead to its own type of disordered eating.

While a dancer's or athlete's focus should be primarily on ensuring adequate fuel for peak performance and recovery, aesthetic goals may still be desired, although they should never be required unless it genuinely aids ability. In these cases, fuelling should be tailored carefully and specifically. The American College of Sports Medicine, the American Dietetic Association, and the Dietitians Of Canada write that "weight change should be accomplished slowly during the off-season, or at the beginning of the season, before competition [or for dancers, performance] begins. Weight gain can be accomplished by the incorporation of additional energy into the diet (500 to 1,000 kcal per day) in conjunction with increased strength training to promote the accretion of the tissue desired… Weight loss is somewhat more problematic, as diminished energy intake can compromise nutrient intake and exercise performance while decreasing both body fat and muscle mass. Consultation with a registered dietitian trained in sport nutrition can help athletes maintain a healthful diet while reducing total energy intake to allow gradual weight loss (approximately 1 to 2 lbs/week or 0.5 to 1.0 kg/week)" (American College of Sports Medicine 3). Essentially, to build muscle, more calories must be consumed than are expended, with additional protein intake often being key, as well as strength training. Similarly, to lose weight, while maintaining muscle, fewer calories should be eaten than are

expended, also with increased protein intake, and with extreme care to ensure that all nutritional requirements are still reached (Trexler 6). Caloric intake should never be dramatically reduced, with recommendations to "use the smallest possible deficit that yields appreciable weight loss" and the dancer or athlete should not remain in an energy deficit for an extended period of time, to avoid the metabolic damage discussed previously (Trexler 4,6).

The Role of Dance Leadership

So how can teachers, directors, and others in positions of leadership within dance help to support their dancers in finding healthy nutritional practices, change the dangerous culture of eating disorders and casting based on unhealthy body types, and provide support and assistance to dancers suffering from eating disorders and energy deficiency? While there is much that dancers can do on their own, including utilizing the information in this paper, research has found that perhaps more than individual variables that may contribute to eating disorders and other unhealthy behaviors, school, or company, culture can play a key role in dancers' behavior, and prevention and intervention programs as well as the creation of a positive and supportive social atmosphere can be incredibly powerful (Nordin-Bates 229).

Leadership should attempt to notice and prevent instances of negative, self-evaluative, perfectionism (Nordin-Bates 225). Frequently in the dance world these traits are prized, but it must be acknowledged that they can be dangerous if left unchecked. Adding additional exercise outside of dance has also been associated with disordered eating, indicating that teachers and directors should attempt to be aware of such habits within their dancers (Nordin-Bates 227). This can be difficult, since, as noted, dance classes do not provide the fitness levels typically required of dancers, and crosstraining is therefore an important part of dancers' training. However,

overtraining can also be dangerous. Perhaps the best way to keep an eye on dancers' exercise habits is not to focus on whether or not they train outside of the dance studio, but whether that exercise level has recently increased dramatically, and perhaps unhealthily.

For dancers with eating disorders, a team of professionals are needed to provide treatment. In fact, these professionals should ideally be available to all dancers, regardless of eating habits. While many dance companies now have physical therapists on staff, this team should also include a physician, a registered dietician, and a mental health professional, and, depending on the physical therapist's focus, a strength coach (Javed 18). Unlike sports teams and high-level athletes, who nearly always have access to such a team, dancers have typically been left to create their own support networks. This frequently leads to dancers not having the help they need if they don't know who to turn to or can't afford professionals specializing in dance and athletics treatment. Dance companies should have a full team already on staff or with official ties to the company and pay for dancers' care. Dance schools, which may not be able to afford this, should keep as many of these professionals on staff as they can, and have strong ties to trusted professionals they can recommend to their students.

If an eating disorder or a symptom of the female athlete triad (such as decline in performance, mood changes, frequent illness or injury, fractures, or dissatisfaction with weight) is diagnosed, dancers should be set up with the right professionals and given a "written or verbal agreement with their primary health care professional to comply with advice to modify diet and exercise, be closely monitored, and place precedence on treatment over training" (Javed 21). This agreement should identify clear goals for treatment and be agreed to by both parties. Additionally, the dancer should work with a physical therapist on any injuries and be completely cleared, before returning to dance (Javed 21). If the agreement is not adhered to by the dancer,

they should be required to take time off from dancing and performing (Javed 21). Because this will be difficult for most dancers, mental health support should be readily available, and dancers should be reminded that seeking help is not a sign of weakness (Javed 18). Because of the interconnected nature of the female athlete triad, a dancer experiencing one disorder of the triad should be evaluated for all three (Javed 21). This is especially true with energy deficiency, which is generally the underlying condition for the other two deficiencies. It has been proven that prevention and early recognition of triad disorders are crucial to ensure timely intervention, meaning that it is essential for teachers and leadership to be constantly on the lookout for warning signs in their dancers and work to create a positive environment that discourages the development of unhealthy habits (Javed 2). It is recommended to use preparticipation evaluation screenings to help identify individuals who may be at risk for the triad, particularly because it is common for dancers to not self-identify due to secrecy, denial, or concerns about losing casting or being stopped from dancing. Anyone analyzing dancers for risks must be especially aware and sensitive about the issue and attempt to create a relationship of mutual trust and honesty.

Given how important it is to diagnose and treat these conditions early on, the general lack of awareness and screening of them is concerning. In recent findings, "only a third of athletes could identify the relationship between menstrual dysfunction and poor bone health. From a quarter to half of athletes fail to recognize short periods of amenorrhea as abnormal, particularly participants in lean sports [such as dance]… Most athletes also fail to recognize low energy availability as a concern and lack nutritional knowledge" (Javed 9). The results from physicians, physical therapists, coaches, and trainers is also concerning, with less than 50% of physicians and physical therapists and less than 10% of coaches able to identify the components of the

female athlete triad. These numbers are certainly even lower among dancers and dance leadership, who already tend to be behind the times in their knowledge of current sports science.

The topics of eating disorders, the female athlete triad, and sports nutrition are large and complicated, especially in dance. Slowly, the dance world is beginning to open up to discussing and addressing these topics, which gives dancers and their artistic leadership an important opportunity to implement new, and scientifically up to date, practices. The abundance of new knowledge in these fields, at least as they pertain to other athletic activities, is exciting, and can be used to guide a new generation of healthier, happier dancers.

Conclusion

While dancers perform activity that is just as intense and extensive, if not more so, as that performed by athletes, support for dancers also tends to be far less, especially from leadership that all too often ignores dancers' health and demands unhealthy, unsustainable practices in training and diet, or withholds casting, or even hiring. These practices are slowly beginning to change, with individuals speaking up about their experiences and some dancers beginning to take their health more seriously, but it is nowhere near enough. The knowledge of sports science that is used by athletes, can, and should, also be applied to dancers. To create a supportive, sustainable, healthy environment in which dancers can thrive physically and emotionally, while performing their best, dance teachers, directors, and other members of dance leadership must step up, provide support for their dancers, and be a part of the change for a new, better culture within the dance world.

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