

The IADMS Bulletin for Dancers and Teachers

Volume 8, Number 1, 2019

Editors-in-Chief

Gayanne Grossman, P.T., Ed.M., B.F.A., F.I.A.D.M.S.

Matthew Wyon, Ph.D.

Nancy Kadel, M.D.

Introduction

Letter from Editors

*Gayanne Grossman, P.T., Ed.M., F.I.A.D.M.S.,
Matthew Wyon, Ph.D., and Nancy Kadel, M.D.*

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

Yiannis Koutedakis, Ph.D.

Articles

Can Off-Studio Training be a Tool for Enhancing Elements of Dance Performance?

*Matthew Wyon, Ph.D., F.I.A.D.M.S. and Nico
Kolokythas, ASCC, M.Sc.*

Do Fitter Dancers Dance “Better”? The Effects of Supplementary Fitness Training in Contemporary Dance

Manuela Angioi, Ph.D.

Ballet Dancers Cardiorespiratory and Muscle Stress Responses to Classes and Rehearsals

Josianne Rodrigues-Krause, Ph.D.

The IADMS Bulletin for Dancers and Teachers

Volume 8, Number 1, 2019

Editors-in-Chief

Gayanne Grossman, P.T., Ed.M., B.F.A., F.I.A.D.M.S.

Matthew Wyon, Ph.D.

Nancy Kadel, M.D.

Introduction

2 Letter from Editors

Gayanne Grossman, P.T., Ed.M., F.I.A.D.M.S., Matthew Wyon, Ph.D., and Nancy Kadel, M.D.

Articles

3 Can Off-Studio Training be a Tool for Enhancing Elements of Dance Performance?

Matthew Wyon, Ph.D., F.I.A.D.M.S. and Nico Kolokythas, ASCC, M.Sc.

6 Do Fitter Dancers Dance “Better”? The Effects of Supplementary Fitness Training in Contemporary Dance

Manuela Angioi, Ph.D.

8 Ballet Dancers Cardiorespiratory and Muscle Stress Responses to Classes and Rehearsals

Josianne Rodrigues-Krause, Ph.D.

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

Yiannis Koutedakis, Ph.D.

Letter from the Editors

Dear Dancers and Teachers,

IADMS Bulletin for Dancers and Teachers is grateful to Matt Wyon PhD and Nancy Kadel MD for moving into editorial roles. We want to thank Elsa Urmston MSc for chairing the Dance Educators' Committee and wish her well as she accepts other responsibilities. A huge welcome to Ellie Kusner MSc in her new role as she steps up to chair this important committee. As always, thank you to Ken Edelman and Balanced Body for the ongoing support that makes this publication possible.

The 2019 programming for *A Day for Teachers Bridging the Gaps: From Theory to Practice* is packed with outstanding speakers and material. Thank you to Healthy Dancer Canada for co-hosting this event. Please join us on Friday October 24, 2019 in Montreal for this wonderfully informative program.

Bridging the Gaps: from Theory to Practice Co-hosted by Healthy Dancer Canada (HDC) and the IADMS Dance Educators' Committee

8:30 – 9:00 am Registration; tea, coffee and light breakfast

9:00 am Opening remarks

Karine Rathle MSc, HDC president

9:00 – 10:00 am Moving to move: an approach to the art of technique. Angeliq Wilkie MSc

10:00 – 10:15 am Refreshments break

10:15 – 11:30 am 'World Café' (1) Balance board - friend or foe? (2) How much is too much? (3) Can vegans dance? (4) The stretching debate.

11:30 am - 12:00 pm (choose one)

- Building anatomical fluency through creative practices. Megan Brunsvold Mercedes BFA, MFA
- Utilizing strategies from motor learning to enhance verbal cueing for dancers. Lisa Donegan Shoaf DPT, PhD & Judith Steel MA, CMA

12:30 – 2:30 pm Lunch with Dance Educators' Roundtable discussions

2:30 – 3:30 pm

- Dancers' perceptions of strength and conditioning training. Melanie Kerr MSc, BA(Hons) & Imogen Aujla MSc, PhD
- Injury associated with dance education: a systematic review. Meghan Critchley MSc
- The effect of the Flipped Classroom Model on altering knowledge and behavior in collegiate dancers. Margaret Willoughby MS & Mary Petrizzi MS
- Gender separation in training: right or wrong? Elizabeth Yutzey MFA & Emma Redding MSc, PhD

3:30 - 3:45 pm Refreshments break

3:45 – 5:00 pm 2020 vision: stress less, create more resiliency and self-care. Lynda Mainwaring PhD, C.Psych

5:00 – 5:30 pm Review, reflection and actions.

Here is a link to programming for the entire 2019 IADMS Annual Conference:

<https://www.iadms.org/page/2019schedule>

This issue of the *IADMS Bulletin for Dancers and Teachers* looks at fitness training and dance. Researchers Josianne Rodrigues-Krause PhD, Yiannis Koutedakis PhD, and Manuela Angioi, PhD have graciously shared their wisdom and written these articles for us.

We always welcome your comments and input. Our email is Bulletin@IADMS.org.

Sincerely,

Gayanne Grossman PT, EdM, BFA, FIADMS
Matt Wyon PhD, FIADMS
Nancy Kadel MD

Can Off-Studio Training be a Tool for Enhancing Elements of Dance Performance?

Matthew Wyon, Ph.D., F.I.A.D.M.S.^{1,2} and Nico Kolokythas, ASCC, M.Sc.^{1,3}

¹Institute of Human Sciences, University of Wolverhampton, WS1 3BD, UK.

²National Institute of Dance Medicine and Science, UK

³Elmhurst Ballet School, Birmingham, B5 7UH, UK.

Can off-studio training be a tool for enhancing elements of dance performance? Are existing dance techniques and methodologies adequate to serve the needs of *today's* aspiring dancer? Do dancers need supplementary fitness training? Is such training going to upset established aesthetic appearances? If a dancer takes time away from studio-work to develop certain non-dance specific elements, is it going to negatively affect dance technique and performance itself?

It is widely acceptable that muscular activity and fitness have been influential to human evolution, as natural selection favoured bodies with adaptations for endurance-based activities¹. Given though that health and physical performance are principal elements of the entire process (sup-optimal health and/or failure to physically perform would hinder evolutionary progress), it could be reasoned that a close inter-relationship ought to be moulded among muscular activity (fitness), health and physical performance. Despite the many cultural and technological changes our species has gone through, this inter-relationship remains essentially unchanged to the present day; if it is to be disturbed, harm occurs. We now know that inactivity is the precursor of almost all non-communicable diseases, such as metabolic syndrome, cardiovascular complications and even cancer², while lack of optimal fitness has been linked to incidents of injury and burnout in different athletic populations, including dancers³⁻⁶.

Traced back to ancient times, dance is a challenging activity⁷. Aesthetic proficiency⁸, appropriate levels of physical fitness⁹, and suitable periods of rest^{10,11} are necessary for modern-day dancers to reach optimal performance¹²⁻¹⁴. For instance, a 3-months aerobic and strength-training programme has positive effects on selected dance performance and fitness parameters in students and, significantly, aerobic capacity and leg-strength improvements do not impede dance performance¹⁵. This is in line with another piece of work in which a supplemental aerobic and strength training programme compared against artistic proficiency in members of a touring ballet company;

all dancers who participated in the intervention group significantly improved their artistic marks compared to their counterparts in the control group¹⁶. Also, a specifically designed strength training programme for professional male ballet dancers led to significant improvements in both upper-body strength and dance performance; pointedly, the weaker dancers were those who received the greatest benefits^{9,17}. The aforementioned information clearly shows that there is plenty of room left for fitness expansions, even in dancers at the height of their professional careers.

Regarding the question as to whether fitness training in general, and strength training in particular, would diminish dancers' aesthetic appearances, the answer is simply "no". This was at least the case in full-time professional ballerinas who undertook a 12-weeks quadriceps and hamstrings strength training. Despite improvements in their muscular strength levels (and dancing ability), no alterations were observed in selected aesthetic components¹⁸. However, appropriate physical fitness levels do not only help to uplift elements of dance performance; they could also help prevent dance injuries¹⁹⁻²¹. Although many perceive movements in dance as not sufficiently powerful to cause the muscular injuries seen in sports, in a period of just 12 months, almost 50% of all professional dancers of a touring company reported one to six days off-action due to a musculoskeletal injury²². Lower limbs²³ and lower back²⁴ seem to be the most frequently injured sites accounting for more than 90% of all dance injuries. Most of these injuries are due to overuse, indicating that the injured dancer is – *inter alia* – inadequately prepared or trained for the tasks he/she undertakes. As the effects of an injury may be highly detrimental for both dancers and dance-companies, there is a need to develop defensive strategies through appropriate off-studio fitness training.

Many dance teachers understandably may ask: why does it all happen? Where is the problem? Are existing dance techniques and methodologies not adequate to attend the needs of *today's* aspiring dancer? Well, techniques and methodologies developed over many years by so many

dance experts are absolutely fine, but perhaps not enough to withstand the ever-increasing physical demands placed upon dancers from current choreography and work schedules. This is partly because, even at the entry stages, most youngsters joining the profession have rather low fitness levels as they normally come from societies where physical activity levels are on constant decline. Indeed, the recent advances of technology drive us on the road of ease and make us develop sedentary behaviours. In 1990 only 11% of the American adults were classified as obese, whereas now this number has gone up to 32%. Doesn't this say something about how technology (cars, mobile phones, etc) is affecting us? According to WHO, more than 80% of the world's adolescent population is insufficiently physically active; this means that less than 20% of all youngsters who wish to pursue a dance career have actually been exposed to physical activities of sufficient level. Therefore, there is a lot of work to be done both in- and off-studio to tune the young human engine, in order to reach the evolutionary standards which transformed humans into effective exercise machines. Aerobic and strength training seem to be the fitness constituents which require constant attention throughout the dancers' careers.

Although often overlooked, there is another reason for adopting off-studio supplemental fitness training; this is the nature of dance itself. For instance, ballet has been characterised by long periods of "rest" and rather short periods of "high" or "very high" exercise intensities²⁵. However, given that fairly strenuous exercise intensities for at least 20 minutes are needed to bring about aerobic fitness changes, it is probable that most ballet activities do not provide an adequate stimulus for such adaptations. The same applies to muscular strength; most dance activities do not elicit adequate impetuses for strength improvements.

In conclusion, muscular activity and fitness have been instrumental to human evolution, and both health and physical performance can be negatively affected by suboptimal fitness levels. This also applies to dancers for whom fitness is just as important as skill development in order to attain performances of high standards. However, even at the height of their professional careers, dancers' fitness levels suffer due to a dance-only training system. This led a number of dance-scientists to generate data on male and female dancers which revealed that supplemental off-studio exercise training can bring about improvements of selected performance and fitness parameters, and at the same time reduce dance injuries, without interfering with key aesthetic requirements. However, any change in the traditional training regimes must be approached thoughtfully, but without fear or guilt.

References

- Wallace IJ, Hainline C, Lieberman DE. Sports and the human brain: an evolutionary perspective. *Handbook of clinical neurology*. Vol 158: Elsevier; 2018:3-10.
- Handschin C, Spiegelman BM. The role of exercise and PGC1 α in inflammation and chronic disease. *Nature*. 2008;454(7203):463
- Allen N, Nevill A, Brooks J, Koutedakis Y, Wyon M. The effect of a comprehensive injury audit program on injury incidence in ballet: a 3-year prospective study. *Clin J Sport Med*. 2013;25(3):373-378
- Koutedakis Y. Burnout in dance: the physiological viewpoint. *J Dance Med Sci*. 2000;4(4):122-127
- Koutedakis Y, Frischknecht R, Vrbová G, Sharp N, Budgett R. Maximal voluntary quadriceps strength patterns in Olympic overtrained athletes. *Med Sci Sports Exerc*. 1995;27(4):566-572
- Twitchett E, Brodrick A, Nevill AM, Koutedakis Y, Angioi M, Wyon M. Does physical fitness affect injury occurrence and time loss due to injury in elite vocational ballet students? *Journal of Dance Medicine and Science*. 2010;14(1):26-31
- Koutedakis Y, Jamurtas A. The dancer as a performing athlete: physiological considerations. *Sports Med*. 2004;34(10):651-661 DoI:10.2165/00007256-200434100-00003.
- Twitchett E, Angioi M, Koutedakis Y, Wyon M. Video analysis of classical ballet performance. *Journal of Dance Medicine and Science*. 2009;13(4):124-128
- Koutedakis Y, Sharp NCC. *The Fit and Healthy Dancer*. Chichester: John Wiley and Sons; 1999.
- Koutedakis Y, Budgett R, Faulmann L. Rest and underperforming elite competitors. *Br J Sports Med*. 1990;24(4):248-252
- Koutedakis Y, Myszkewycz L, Soulas D, Papapostolou V, Sullivan I, Sharp NC. The effects of rest and subsequent training on selected physiological parameters in professional female classical dancers. *Int J Sports Med*. 1999;20(6):379-383 DoI:10.1055/s-2007-971148.
- Angioi M, Metsios GS, Koutedakis Y, Wyon MA. Fitness in contemporary dance: a systematic review. *Int J Sports Med*. 2009;30(7):475-484 DoI:10.1055/s-0029-1202821.
- Angioi M, Metsios GS, Twitchett E, Koutedakis Y, Wyon M. Association between selected physical fitness parameters and esthetic competence in contemporary dancers. *J Dance Med Sci*. 2009;13(4):115-123
- Twitchett E, Koutedakis Y, Wyon M. Physiological fitness and classical ballet performance: a brief review. *J Strength Cond Res*. 2009;23(9):2732-2740 DoI:10.1519/JSC.0b013e3181bc1749.
- Koutedakis Y, Hukam H, Metsios G, Nevill A, Giakas G, Jamurtas A, Myszkewycz L. The effects of three months of aerobic and strength training on selected performance and fitness-related parameters in modern dance students. *J Strength Cond Res*. 2007;21(3):808-812 DoI:R-2085610.1519/R-20856.1.
- Twitchett E, Angioi M, Koutedakis Y, Wyon M. Do increases in selected fitness parameters affect the aesthetic aspects of classical ballet performance. *Med Probl Perform Artists*. 2011;26(1):35-38
- Angioi M, Metsios G, Twitchett E, Koutedakis Y, Wyon M. Effects of supplemental training on fitness and aesthetic competence parameters in contemporary dance: a randomised controlled trial. *Med Probl Perform Artists*. 2012;27(1):3-8
- Koutedakis Y, Sharp NC. Thigh-muscles strength training, dance exercise, dynamometry, and anthropometry in professional ballerinas. *J Strength Cond Res*. 2004;18(4):714-718 DoI:DOI: 10.1519/13983.1.
- Koutedakis Y, Khalouha M, Pacy P, Murphy M, Dunbar

- G. Thigh peak torques and lower-body injuries in dancers. *J Dance Med Sci.* 1997;1(1):12-15
20. Koutedakis Y, Sharp NC. Seasonal variations of injury and overtraining in elite athletes. *Clin J Sport Med.* 1998;8(1):18-21
 21. Wyon M, Koutedakis Y. Muscular Fatigue: considerations for dancers. *J Dance Med Sci.* 2013;17(2):77-83
 22. Allen N, Nevill A, Brooks J, Koutedakis Y, Wyon M. Ballet injuries: injury incidence and severity over 1 year. *J Orthop Sports Phys Ther.* 2012;42(9):781-790 DoI:10.2519/jospt.2012.3893.
 23. Caine D, Goodwin BJ, Caine CG, Bergeron G. Epidemiological review of injury in pre-professional ballet dancers. *J Dance Med Sci.* 2015;19(4):140-148
 24. Koutedakis Y, Frischknecht R, Murthy M. Knee flexion to extension peak torque ratios and low-back injuries in highly active individuals. *Int J Sports Med.* 1997;18(4):290-295 DoI:10.1055/s-2007-972636.
 25. Wyon M, Twitchett E, Angioi M, Clarke F, Metsios G, Koutedakis Y. Time motion and video analysis of classical ballet and contemporary dance performance. *Int J Sports Med.* 2011;32(11):851-855 DoI:10.1055/s-0031-1279718.

Do Fitter Dancers Dance “Better”?

The Effects of Supplementary Fitness Training in Contemporary Dance

Manuela Angioi, Ph.D., Centre for Sports and Exercise Medicine, Queen Mary University of London, UK

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-plié* 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

This article has been adapted from Angioi M, et al. Effects of Supplemental Training on Fitness and Aesthetic Competence Parameters in Contemporary Dance: A Randomised Controlled Trial. *Med Probl Perform Art.* 2012; p:3-8. It was previously published in the *IADMS Bulletin for Dancers and Teachers*, Volume 5, Number 1, 2014;p:7-8.

capacity as well as all scoring similarly in the performance – 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, transi-

tory 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.

Ballet Dancers Cardiorespiratory and Muscle Stress Responses to Classes and Rehearsals

Josianne Rodrigues-Krause, Ph.D., Federal University of Rio Grande do Sul, Porto Alegre/RS, Brazil

Ballet dance is intermittent exercise, involving repeated eccentric muscle contractions. Eccentric muscle contractions control the body movements against gravity; this means that the muscle contracts while it lengthens, such as the calf muscles when landing from a jump. This type of muscle contraction is responsible for inducing micro-damage to the muscle, that can lead to beneficial adaptations if there is enough recovery time or muscle fatigue, or to inflammation and damage when there isn't enough recovery time during the day or sleep time at night.

Dancers' high prevalence of pain and injuries are usually muscle-related and associated to delayed onset muscle soreness, a common characteristic of exercise with high eccentric loads. Moreover, the high frequency of injury in dancers has been attributed to inadequate levels of fitness, such as aerobic conditioning and strength. Furthermore, differences between cardiorespiratory demands of dance classes, rehearsals and performances have been described for different dance styles; with class consistently being less demanding than rehearsals and performances. It is also known that muscle stress biomarkers of cell damage are accentuated in response to higher aerobic exercise intensities, which has been reported for activities such as cycling and running, but not for dancers so far. Therefore, we looked at whether rehearsals caused more muscle damage than dance class because of the differences in cardiorespiratory demands between the two, which might underlie the high level of muscle injuries in dancers.

We compared ballet dancers' cardiorespiratory and muscle stress responses during a ballet class and a ballet rehearsal. Twelve female advanced level ballet dancers (mean 20.5 yrs, 14 yrs experience of dancing, 14 h dancing/wk, BMI=19.6 kg/m², and free from injuries in the

last 3 months), performed both their usual ballet class and the rehearsal of *Paqueta* ballet (*corps de ballet*). They wore a portable gas analyser and heart rate monitor to measure the cardiorespiratory intensity of the class and rehearsal. Blood samples were taken immediately after and 48 hours after both trials to monitor lipid peroxides (LPO). This is a biochemical product released from the membrane of damaged muscle cells, which can be detected in the blood, indicating muscle damage or adaptation. Dancers also performed a maximum effort test in a treadmill, in order to check their maximum aerobic capacity (VO₂max).

The results confirmed the already reported differences between the cardiorespiratory demands of dance and class and rehearsal; the average demand of dance class was 53.5% of the dancers' VO₂max, whilst rehearsal was at 66.2% of their VO₂max. The data from the blood tests were the opposite, with the dance class having higher levels of LPO than rehearsals. In other words, there were higher levels of muscle stress markers after the class than the rehearsal, but blood markers in both instances were below muscle damage levels and had returned to normal resting levels within 48 hours.

Trying to understand why there was a dichotomy between the biochemical and cardiorespiratory responses, we explored the specificities of each situation, class and rehearsal. In fact, exercises during class focused on technique development, involving many repetitions of the same moves performed in isolation that involved eccentric (e.g landings) and isometric (e.g balances) muscle activity. On the other hand, during the rehearsals a variety of dynamic moves, combining technical-artistic skills are performed, mixing explosive jumps with large range of motion, turns and waltz across-the-floor, with sequences of longer duration and lower intensities. This may explain the higher aerobic demands from rehearsals. Thus, it seems that the sub-maximum eccentric loads provided in class seem to be enough to promote micro-damages to the cell membrane in optimal levels to promote muscle adaptations.

This article has been adapted from Rodrigues-Krause J, et al., Ballet dancers cardiorespiratory, oxidative and muscle damage responses to classes and rehearsals. *Eur J Sport Sci.* 2013; 14(3): 199-208.

In conclusion, VO_2 responses were lower in class than rehearsal, confirming data already reported, and the need for supplementary cardiorespiratory training is recommended. Regarding biochemical muscle stress responses,

it seems that ballet classes prepare the dancers in relation to muscle stress responses for their rehearsals, at least considering part-time, technically skilled dancers.

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

Yiannis Koutedakis, Ph.D.

Institute of Sports, University of Wolverhampton, WS1 3BD, UK
Department of Exercise Sciences, Thessaly University, Trikala, Greece

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 training¹ and over-training^{2,3}, fitness⁴, injuries⁵ 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-students⁸. 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, respec-

tively) 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

This article was generated from Koutedakis Y., et al., Performance and Fitness Parameters Following 3-months of Aerobic and Strength-Training in Modern Dance Students. *J Strength Con Research* 2007 21(3):808-812.

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 contols⁹.

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 athletes¹⁰. 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.

References

1. Wyon M, Twitchett E, Angioi M, Clarke F, Metsios G, Koutedakis Y. Time motion and video analysis of classical ballet and contemporary dance performance. *Int J Sports Med.* 2011;32(11):851-855 DoI:10.1055/s-0031-1279718.
2. Koutedakis Y. Burnout in dance: the physiological viewpoint. *J Dance Med Sci.* 2000;4(4):122-127
3. Koutedakis Y, Frischknecht R, Vrbová G, Sharp NC. Maximal voluntary quadriceps strength patterns in Olympic overtrained athletes. *Med Sci Sports Exerc.* 1995
4. Angioi M, Metsios GS, Koutedakis Y, Wyon MA. Fitness in contemporary dance: a systematic review. *Int J Sports Med.* 2009;30(7):475-484 DoI:10.1055/s-0029-1202821.
5. Allen N, Nevill A, Brooks J, Koutedakis Y, Wyon M. The effect of a comprehensive injury audit program on injury incidence in ballet: a 3-year prospective study. *Clin J Sport Med.* 2013;25(3):373-378
6. Amorim T, Koutedakis Y, Nevill A, Wyon M, Maia J, Machado JC, Marques F, Metsios GS, Flouris AD, Adubeiro N, Nogueira L, Dimitriou L. Bone mineral density in vocational and professional ballet dancers. *Osteoporos Int.* 2017;28(10):2903-2912 DoI:10.1007/s00198-017-4130-0.
7. Amorim T, Wyon M, Maia J, Machado J, Marques F, Metsios G, Flouris A, Koutedakis Y. Prevalence of low bone mineral density in female dancers: a systematic review. *Sports Med.* 2015;45(2):257-268 DoI:10.1007/s40279-014-0268-5.
8. Koutedakis Y, Hukam H, Metsios G, Nevill A, Giakas G, Jamurtas A, Myszkewycz L. The effects of three months of aerobic and strength training on selected performance and fitness-related parameters in modern dance students. *J Strength Cond Res.* 2007;21(3):808-812 DoI:R-2085610.1519/R-20856.1.
9. Twitchett E, Angioi M, Koutedakis Y, Wyon M. Do increases in selected fitness parameters affect the aesthetic aspects of classical ballet performance. *Med Probl Perform Artists.* 2011;26(1):35-38
10. Sanders DJ, Walker AJ, Prior KE, Poysick AN, Arent SM. Training Demands and Physiological Profile of Cross-Disciplined Collegiate Female Dancers. *J Strength Cond Res.* 2019



Increased performance.
Decreased injuries.

Balanced Body® and Pilates keep your dancers moving.

Find out more at pilates.com.

YOUR PRACTICE.
OUR FULL SUPPORT.

Let's talk!  

 balanced body®

pilates.com
1-877-PILATES (745-2837)

IADMS International Association
for Dance Medicine & Science

29TH ANNUAL CONFERENCE

MONTREAL, CANADA

Friday Oct 25, 2019



www.iadms.org

A Day For Teachers

A program of lectures, workshops and discussions drawing from the latest dance medicine and science research to inspire, refresh and reaffirm dance teachers' practice in the studio.

Ideal for teachers new to dance medicine and science ideas, as well as those with experience.

Contact Ellie Kusner, IADMS Dance Educators' Committee
Chair for further details:
education@iadms.org



Megan Connolly, Photo Credit: Maggie Lorraine