Strength and Conditioning for Dancers (7DC001)

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Portfolio

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Muscular Strength for Dance

Introduction

This portfolio summarises 5 applied physiology lectures on the topic of muscular strength for dance and aims to highlight essential points relative to developing and maintaining optimal fitness and health for professional dancers with a view to improving performance, quality of life, and lengthening career span. Due to the fact that the research in dance cited in this portfolio has been undertaken on modern contemporary and/or classical ballet dancers, the term *dance* in this work refer to these two genres.

Dance demands precision, strength, endurance, agility, artistry, musicality, aesthetics and flexibility- to name but a few aspects. It is steeped in tradition and although over the last 25 years has been opening-up to new teaching ideas and physical concepts, the traditional aesthetic, etiquette and training philosophies, especially in classical ballet still very much remain. This despite scientific evidence that shows changes are needed. Wyon, in "Cardiorespiratory Training for Dancers" observed that:

> "Dance performance has been classified as high-intensity intermittent exercise that utilizes the aerobic and glycolytic energy production systems. Dance class and rehearsal have been shown to inadequately stress these energy systems and supplemental training is one method of preparing the body to meet these demands." (Wyon, 2005, p. 7)

The vast majority of dancers have been conditioned to believe that supplementary fitness, endurance and weight training will create unnecessary wrong muscles and ugly movement. Twitchett, Koutedakis, & Wyon wrote “dancers have been wary of strength training because they perceive this leads to aesthetically undesirable hypertrophy” (2009, p. 2732). Dancers regard the ballet class as a complete and more than sufficient training, however, Brinson and Dick state in *Fit to Dance*, “Class is by no means adequate fitness training, because the workload is not specific enough to train the different fitness parameters, nor is it graduated, nor tailored to individual needs.” (2006, p. 122). This firmly suggests that many dancers are actually unfit to do a job where fitness is required in order to do the job well and to avoid injury.

Lecture 1: Energy Productions

<u>The energy systems</u>

ATP is energy in chemical form and is transformed in our bodies to chemical work, mechanical work, electrical work and thermoregulation (Koutedakis & Sharp, 1999, pp. 4-5)

ATP is resynthesized through three different systems. The phosphagen ATP PCr anaerobic system is used for very powerful movements, e.g. the beginning of a race (Baechle & Earle, 2008, p. 24) or a strenuous choreography. Here, energy rich phosphocreatine (PC) stored directly in the muscle cells is utilised. Phosphocreatine stores recuperate in the resting phase after physical activity (Koutedakis & Sharp, 1999, pp. 15-16).

The lactic anaerobic acid/glycosis system lasts for around 45 seconds of intensive exercise, e.g. for a 400 meter sprint (or ménage coda). This system is more complicated than the ATP PCr and nutritional intake plays an important role (Koutedakis & Sharp, 1999, pp. 16-18).

The aerobic oxidative system relies on the break-down of fats and carbohydrates and could, in theory, go on for an indefinite amount of time. Here, pyruvic acid is produced and enters a biochemical procedure within the mitochondria called the *Krebs Cycle* (Koutedakis & Sharp, 1999, pp. 18-20) and (Baechle & Earle, 2008, pp. 29-30)

These three systems synchronise to work simultaneously at different intensities and volumes, depending on physical and situational demands. (McArdle, Katch, & Katch, 1996, pp. 195 & 129-130) . Dancers need to train all three systems, although they mainly use the oxidative system (Koutedakis & Jamurtas, 2004).

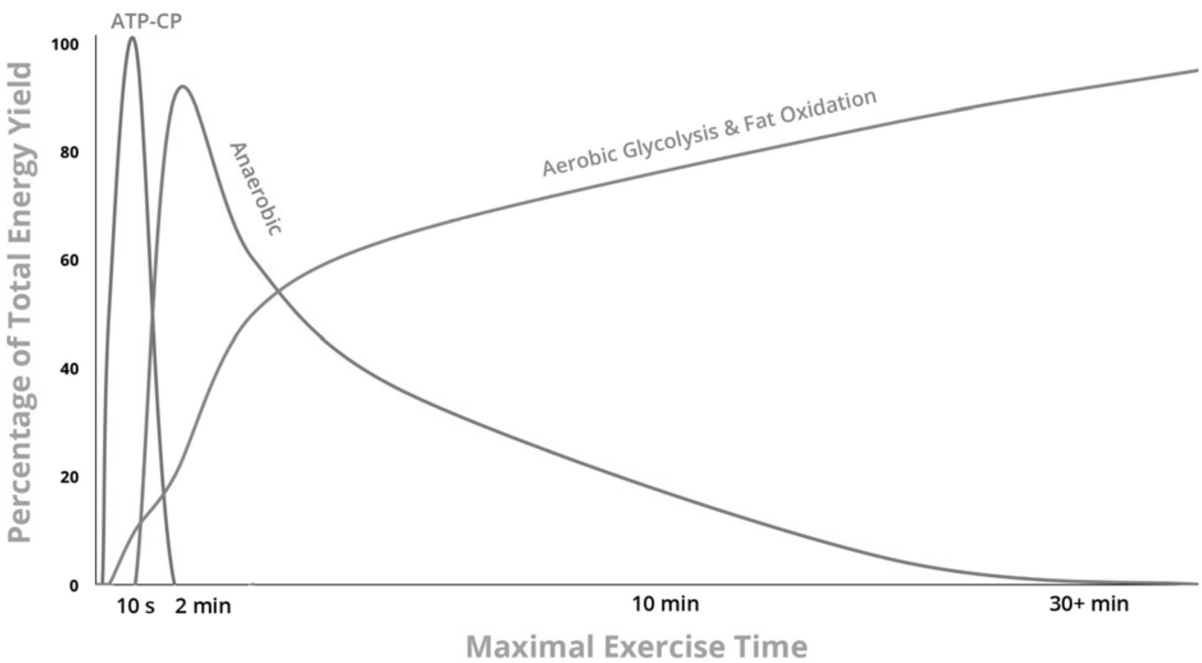

Figure 1: *The three energy systems contribute to athletic performance*

(Sindon, 2016)

Training and muscle types

To increase the oxidative capacity, aerobic training must be undertaken. Ballet performances frequently demand aerobic capabilities, which class does not train therefore, dancers need regular aerobic training of at least 20 minutes at an appropriate heart rate level (roughly: age + 25 − 220) (Koutedakis & Sharp, 1999, p. 104) e.g. running, swimming, cycling or a choreographed aerobic training similar to those used in the DAFT fitness test (Twitchett, Nevill, Angioi, Koutedakis, & Wyon, 2011b).

Training for muscular strength for dancers should be undertaken at 60%-70% of the maximum (1-RM) this being the amount that can be moved just once (Koutedakis & Sharp, 1999, p. 122).

Individuals react differently to training. Dancers with predominantly white fibres can move faster, and develop bulkier muscles than those with slow, red fibres who can develop more endurance (Koutedakis & Sharp, 1999, p. 70).

Twitchett et.al wrote that increasing the oxidative capacity (VO_2 max) increases stamina and guards against fatigue induced injuries (2011a, p. 35) In order to be able to train at an optimal level for increased stamina and strength, optimal nutrition is needed.

Nutrition- the basis of ATP

Protein is used mainly for cell repair. Mixing complete and incomplete proteins, e.g. potato mixed with egg, will bring more nutritional value than complete protein alone, e.g. a steak. For dancers, 1-2 grams of protein per kg body weight per day is advised (Koutedakis & Sharp, 1999, pp. 32-47).

Fat should not consist of more than 35% of the overall daily energy intake. Fat is normally used for low intensity muscular work, in order to save carbohydrates stores for more demanding work. The fitter a person is, the greater the carbohydrate sparing. Fat is vital as protection for the organs and for insulation (McArdle, Katch, & Katch, 1996, p. 20). It absorbs vitamins, forms an essential part of cell membranes and nerve fibres, provides up to 70% of energy while resting, and is involved in the production of steroid hormones (Koutedakis & Sharp, 1999, pp. 29-31)

Carbohydrate, for physically active people, should account for roughly 60% of daily energy intake. Carbohydrate/Glycogen is stored in the muscles and the liver and carbohydrate intake must be sufficient in order to maintain these glycogen stores. (McArdle, Katch, & Katch, 1996, p. 10).

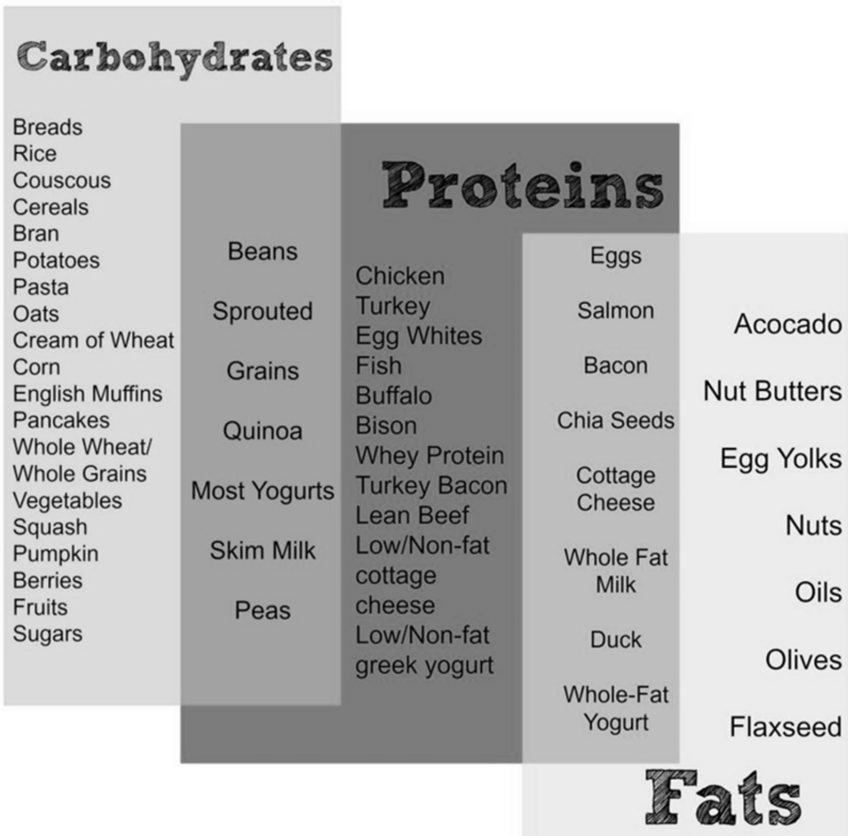

Figure 2: *Proteins, Carbohydrates and Fats*

(McGlinn, 2018)

Lecture 2: Warm-up

<u>Muscles</u>

All the components of physical fitness are related to muscle.

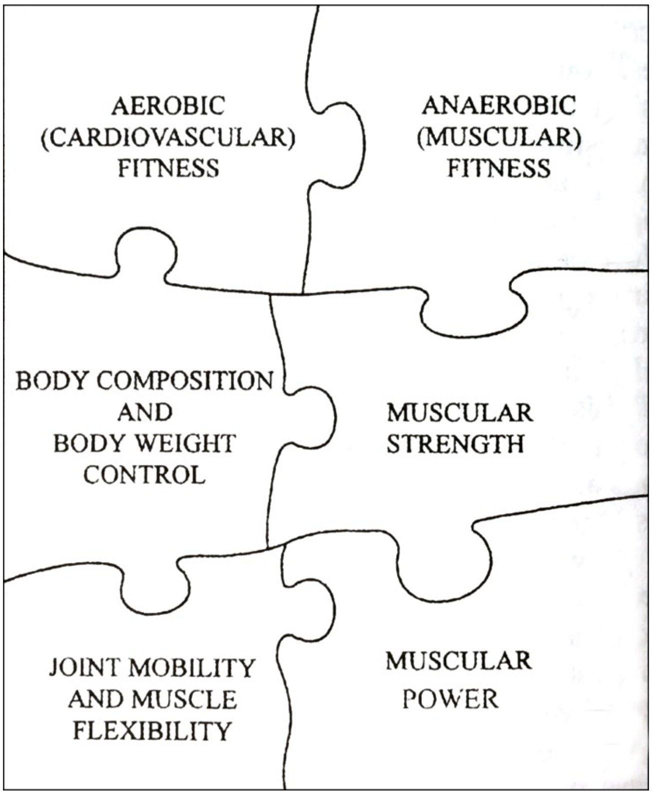

Figure 3: *Fitness Jigsaw*
(Koutedakis & Sharp, 1999, p. 90)

In order for the muscle to function energy is needed. Raising the temperature of the muscle increases the rate at which enzymatic activity takes place in the sarcomere within the muscle fibre. Movement (i.e. warm-up) will cause temperature increase. A 1° increase in muscle temperature can cause up to a 13% increase in speed of muscle cell metabolism (Koutedakis & Jamurtas, 2004, pp. 164-165) which increases physical performance. The best physical performance can be reached with muscle temperatures of 38.5° to 39° above which the muscles ability to use oxygen then decreases (Astrand & Rodahl, 1986).

Muscle fibre is made up from bundles of myofibril. Each myofibril is made up of myofilaments which are made up from a long line of sarcomere. Muscle contraction takes place within the sarcomere. At each end of the sarcomere a zig-zag line containing the proteins actin and myosin is found; the “z-lines”. (Koutedakis & Sharp, 1999, pp. 78-79). When the muscle is moved and stretched by exercise it can become stronger. Here the z-lines part so that new sarcomeres can be inserted.

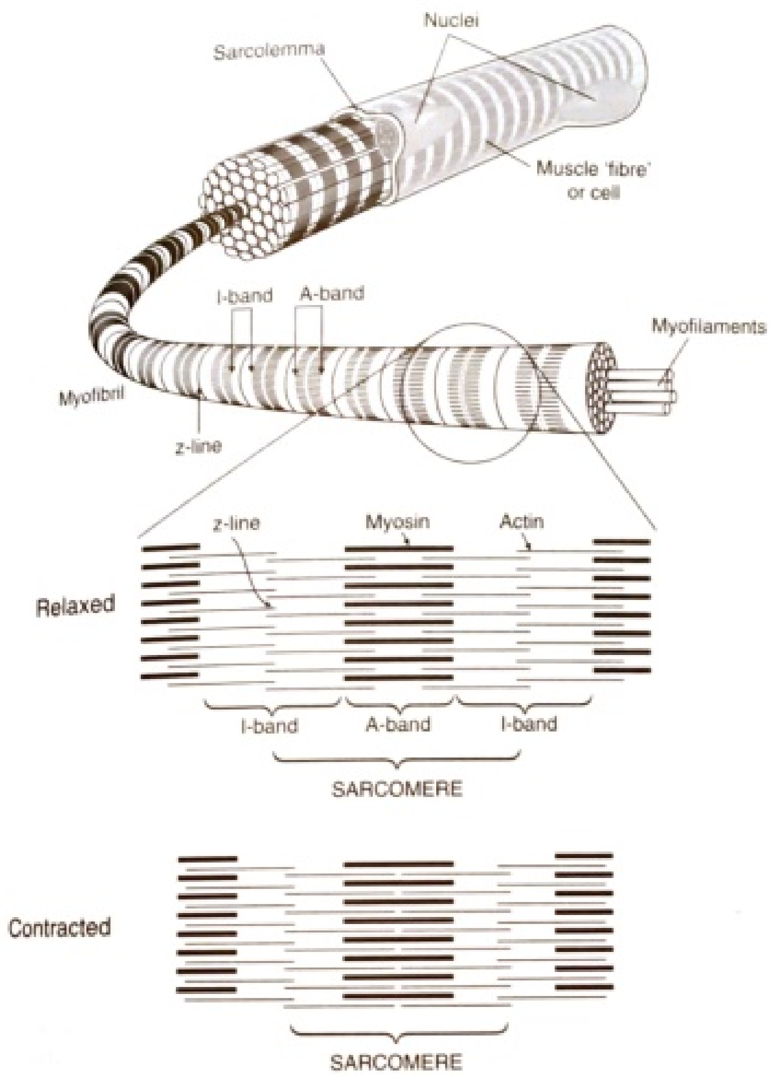

Figure 4: *Sarcomere*

(Koutedakis & Sharp, 1999, p. 79)

Benefits of warm-up:

- Neuromuscular transmissions are improved resulting in increased reaction times, (Kelitman & Feiveson, 1938).
- Muscle contractility and force/strength are improved (DeRenne, Ho, & Hetzler, 1992).
- Viscosity of connective tissue and muscle increases improving flexibility (Whelan, Gass, & Moran, 1996).
- Synovial fluid production increases reducing friction in the joints while activating innate shock absorption (Hamil & Knutzen, 2009) helping to guard against injury and protect delicate tissues such as the cartilage in the knees.
- Anaerobic power bursts and stamina (aerobic capabilities) are enhanced (Sen, Grucza, & Pekkarinen, 1992) & (McKenna, Green, & Shaw, 1987).
- Warming-up enhances the heat dissipating activity (Torii, Yamasaki, & Sasaki, 1996).

Warm-up structure

Koutedakis and Sharp recommend the following:

- Environment approximately 21°.
- Warm clothing.
- Intensity depends on fitness levels; duration depends on fitness, time of year and the individual's idiosyncrasy.
- Exercises should be complex enough to avoid boredom.
- Warm-up in a different setting to that of class or performance.

- Exercises from simple to complex, easy to difficult, large to small muscle groups.
- Stretch only when warm.
- The resting period between warming-up and dancing should not be longer than 15 minutes.

The warm-up for dancers should be of no less than 20 minutes, divided into 3 phases.

Phase 1:5-10 mins. Aims: activate the cardiovascular system.

- Easy jogging.
- Running activities/games.
- Gentle stretching of large muscle groups.

Phase 2: 10-15 mins. Aims: stimulation of energy pathways, elevation of heart-rate and muscle temperature, increase the degree of muscle and tendon stretching plus injury prevention.

- Repeat phase 1 with higher intensity.
- Stretching of 30 -40% at the end of phase two.

Phase 3: 5-10 mins.

- Exercises/movements that the individual requires. For example, knee, back or stomach exercises, proprioceptive training such as balancing or rolling, range of motion.

(Koutedakis & Sharp, 1999, pp. 167-168)

Stretching

- When cold, muscle spindles are more sensitive and can create vigorous muscle contraction to counter-act overstretching and injury.
- After undertaking static or PNF (Proprioceptive Neuromuscular Facilitation) stretching, vertical jump performance is diminished for 15 minutes afterwards, therefore, PNF or static stretching should not be performed immediately prior to an explosive athletic movement (Bradley, Olsen, & Portas, 2007)
- Muscles account for only 10% of flexibility (Koutedakis & Sharp, 1999, p. 130).
- Stretching as part of cool-down will minimise muscle soreness and stiffness plus repair of minor muscle damage can be helped (Koutedakis & Sharp, 1999, p. 141).
- Stretching can positively affect muscular strength. For example, when a bone grows the muscle undergoes stretching followed by strengthening (Koutedakis & Sharp, 1999, p. 136).

Warm-down/ Cool down

- Should be the reverse of the warm-up.
- Heartrate, blood pressure and breathing do not undergo rapid changes.
- Hormone Norepinephrine responsible for increasing the heartbeat is reduced.
- Optimal thermoregulation is achieved.
- Post exercise soreness is minimised.
- Muscle recovery post exercise is boosted.

(Koutedakis & Sharp, 1999, pp. 169-171)

- The liver and the heart tissue will can utilise lactic acid, therefore reducing post exercise muscle soreness (Gladden, 1989).

Lecture 3: Definition-measurement-aspects affecting strength

Definition of health

The WHO defines as "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). Strength and fitness can be defined as the ability to meet the demands of the physical component. Muscle is the only organ with the ability to adapt to physical components.

Muscle strength can be defined as "the maximal force that can be exerted in a single voluntary contraction" (Koutedakis & Sharp, 1999, p. 114) called the 1-RM; one repetition maximum, (McArdle, Katch, & Katch, 1996, p. 418).

Muscle contraction types

1. Isotonic: this contraction produces the same amount of tension and tone as it overcomes resistance.
2. Concentric: the muscle shortens while overcoming resistance.
3. Eccentric: the muscle lengthens while contracting, e.g. contraction of quadriceps going down stairs.
4. Isometric: tension is developed without change in the external length of the muscle, e.g. pushing on a wall.
5. Isokinetic: development of maximal tension as the muscle shortens at a consistent velocity throughout the motion spectrum.

(Koutedakis & Sharp, 1999, p. 84)

What affects muscle?

- Gender: Males can build more strength and power than females (Baechle & Earle, 2008, pp. 151-152)
- Age: Ageing causes a 40 -50% muscle mass reduction between ages 25-80 (due to lack of retention of proteins) resulting in loss of strength, which results in loss of bone-mass. Neural, pulmonary and cardiovascular functions also deteriorate with age (McArdle, Katch, & Katch, 1996, pp. 639-642).
- Technique: Fast and slow motor units are employed during muscle co-ordination and synchronisation (which takes place in the brain). Coordination can positively affect muscular strength through controlling the recruitment of the right motor units (McArdle, Katch, & Katch, 1996, p. 351).
- Muscle fibre types: Slow Type I, oxidative fast type IIa, glycolytic fast type IIb. Fast fibres possess explosive strength, slow fibres, endurance strength (Koutedakis & Sharp, 1999, pp. 67-70). Fibre diameter, not type determines strength.
- Growth and development: females reach puberty earlier than males and can therefore, at this point, be stronger. However, when males enter puberty their strength overtakes that of their female counterparts (Koutedakis & Sharp, 1999, p. 218). See *Figure 5.*
- Training: research from Meijer, et al. has shown despite having significantly larger muscle fibres the power-generating capacity of bodybuilders was not higher than that of controls. This suggests that low- to moderate-intensity, high-volume training, as performed by bodybuilders, does not affect peak power and is even detrimental to specific tension (Single muscle fibre

contractile properties differ between bodybuilders, power athletes and controls, 2015).

- Strength training will cause the muscle to lengthen as a result of added sarcomeres; it may be that this lengthening of the muscle benefits flexibility in the body (Koutedakis & Sharp, 1999, p. 135).

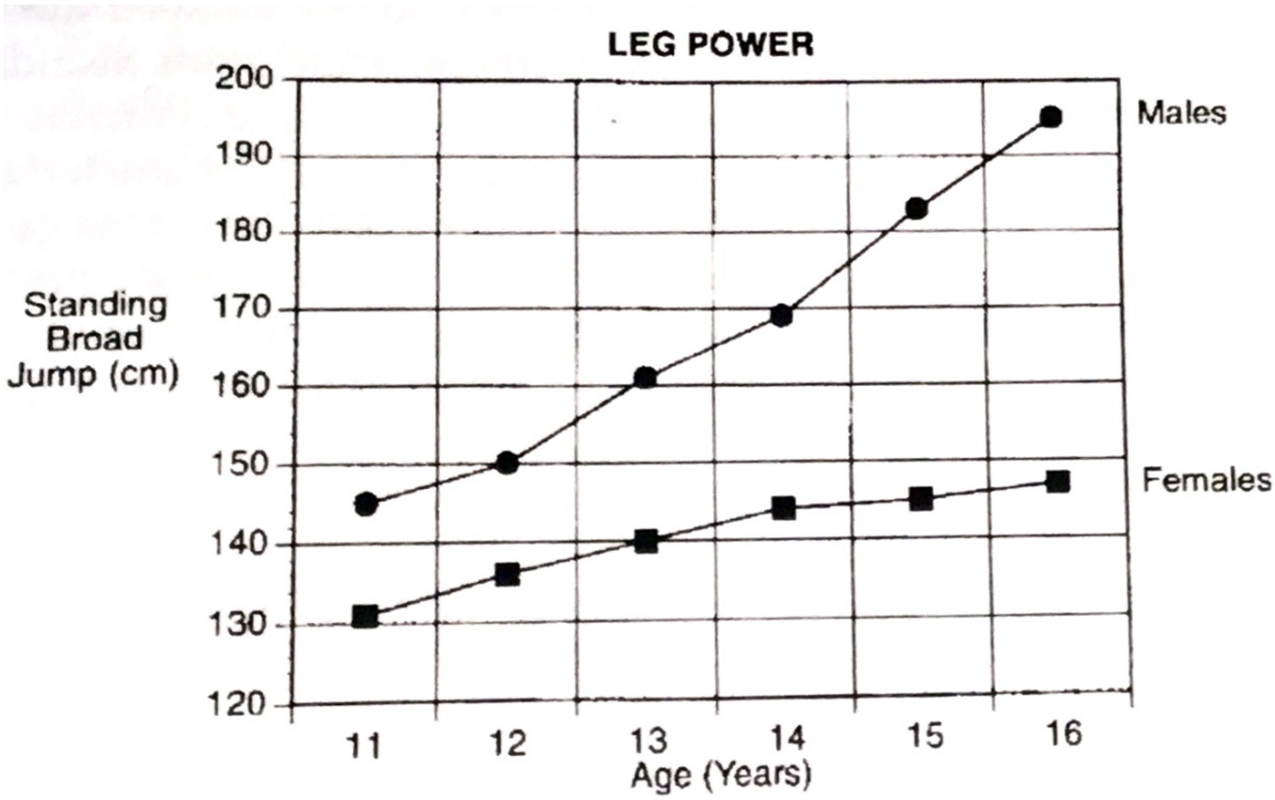

Figure 5: *The development of certain aspects of physical fitness over adolescence*

Source: Northern Ireland Fitness Survey (1990) in Koutedakis & Sharp (1999, p. 283).

Table 5 Boys' anthropometric and physical fitness characteristics by age (years). Results are mean (SD)

	11 (n=222)	12 (n=210)	13 (n=215)	14 (n=208)	15 (n=219)	16 (n=211)	17 (n=180)	18 (n=89)
Height (mm)	1449 (69)	1503 (76)	1566 (82)	1621 (84)	1689 (68)	1734 (70)	1760 (67)	1748 (54)
Weight (kg)	39·7 (7·2)	42·1 (8·8)	46·5 (4·4)	51·7 (10·1)	58·0 (9·5)	64·2 (9·6)	66·5 (9·0)	67·0 (8·9)
Body mass index	17·8 (2·4)	18·5 (2·8)	18·8 (2·7)	19·5 (2·6)	20·2 (2·7)	21·3 (2·7)	21·4 (2·3)	21·9 (2·5)
20 metre shuttle run test (laps)	61 (19)	65 (17)	72 (19)	79 (20)	86 (20)	90 (18)	96 (18)	98 (20)
Sit and reach (cm)	16·5 (6·0)	15·0 (6·5)	16·0 (7·0)	17·0 (6·5)	19·5 (7·5)	22·0 (7·5)	23·5 (8·5)	24·5 (7·0)
Standing broad jump (cm)	145 (19)	150 (20)	161 (23)	169 (25)	183 (24)	195 (24)	200 (24)	205 (22)
No of sit ups completed in 30 secs	22 (4)	23 (4)	24 (4)	25 (4)	25 (4)	26 (4)	26 (4)	26 (4)
Grip strength (kg)	20 (4)	23 (5)	26 (6)	30 (7)	37 (8)	42 (7)	46 (7)	46 (7)
10×5 m sprint (millisecs)	219 (19)	216 (18)	208 (16)	203 (16)	198 (15)	191 (14)	189 (14)	191 (14)

Table 6 Girls' anthropometric and physical fitness characteristics by age (years). Results are mean (SD)

	11 (n=224)	12 (n=237)	13 (n=229)	14 (n=226)	15 (n=219)	16 (n=227)	17 (n=200)	18 (n=121)
Height (mm)	1471 (75)	1511 (77)	1563 (67)	1594 (60)	1602 (60)	1620 (59)	1626 (63)	1626 (56)
Weight (kg)	40·6 (8·9)	43·1 (8·8)	48·7 (9·3)	52·9 (7·9)	54·0 (7·4)	56·5 (7·7)	56·6 (6·9)	57·2 (7·6)
Body mass index	18·6 (2·2)	18·8 (2·8)	19·8 (3·2)	20·8 (2·8)	21·0 (2·6)	21·5 (2·7)	21·4 (2·4)	21·6 (2·6)
20 metre shuttle run test (laps)	41 (13)	47 (14)	48 (15)	49 (16)	49 (14)	50 (15)	50 (16)	44 (14)
Sit and reach (cm)	20·5 (6·5)	20·5 (6·0)	21·5 (6·5)	24·5 (6·5)	25·0 (6·5)	25·0 (7·0)	26·0 (7·5)	23·5 (7·0)
Standing broad jump (cm)	131 (19)	136 (19)	140 (21)	144 (22)	145 (21)	147 (22)	151 (22)	144 (19)
No of sit ups completed in 30 secs	19 (4)	20 (4)	19 (4)	20 (4)	20 (4)	20 (4)	19 (5)	19 (5)
Grip strength (kg)	19 (4)	20 (4)	23 (4)	26 (4)	27 (4)	28 (5)	29 (5)	27 (4)
10×5 m sprint (millisecs)	235 (18)	226 (20)	227 (17)	224 (19)	221 (22)	220 (19)	220 (20)	232 (18)

Figure 6: *Anthropometric and physical fitness characteristics by age: Comparison of gender in adolescence*

(Riddoch, Savage, Murphy, Cran, & Boreha, 1991, p. 1429)

Testing for muscular strength

Strength can be tested dynamically e.g. with vertical jump height and running speed tests and statically e.g. with isokinetic machines, cable tensionmeter, back-leg lift and hand grip dynamometer. The hand grip dynamometer test has been shown to be a predictor of both absolute muscular strength and endurance (Trosclair, 2011)

Power ÷ Time = Strength Power = Strength x Time

In tests it has been shown that dancers are not strong compared to other physical activity groups.

Mean Peak Power (MPP), Mean Power (MP) and Time to Peak Power (TPP) values obtained from British elite athletes and dancers

Activity	Sex	MPP (Watts)	MP (Watts)	TPP (Seconds)
Rowers	Males	1140	880	5.1
Skiers	Males	982	685	5.4
Fencers	Males	809	673	6.6
Gymnasts	Males	790	690	6.0
Dancers (contemporary)*	Males	740	580	7.4
Rowers	Females	690	595	6.3
Dancers (ballet)*	Males	680	580	9.0
Dance students*	Males	650	510	7.1
Gymnasts	Females	580	500	7.0
Dance students*	Females	477	374	8.5
Dancers (contemporary)*	Females	465	359	8.3
Dancers (ballet)*	Females	410	329	8.5

* = Healthier Dancer Programme data

Figure 7: *Comparison of strength dancers and various physically active groups 1* (Brinson & Dick, 2006, p. 66)s

Mean Peak Torque values for the muscles involved in knee extension and knee flexion at 1.04 rad/sec, in British elite athletes and dancers			
Activity	**Sex**	**Knee Extension (Nm)**	**Knee Flexion (Nm)**
Rugby players	Males	372	169
Rowers	Males	350	165
Skiers	Males	296	162
Fencers	Males	273	145
Squash players	Males	280	136
Rowers	Females	212	89
Dancers (contemporary)*	Males	196	94
Dance students*	Males	188	89
Dancers (ballet)*	Males	181	82
Squash players	Females	168	79
Dancers (contemporary)*	Females	133	68
Dance students*	Females	126	64
Dancers (ballet)*	Females	118	59

* = Healthier Dancer Programme data

***Figure 8**, Comparison of strength dancers and various physically active groups 2*
(Brinson & Dick, 2006, p. 67)

Reasons for muscular weakness in ballet dancers stem from the belief that supplementary strength training will ruin the aesthetic of the physique and movement and that a ballet class is a complete and sufficient work-out. Contrastingly, research shows that supplementary fitness training has a positive effect on aspects related to aesthetic dance performance (Twitchett, Angioi, Koutedakis, & Matthew Wyon, 2011a) & (Angioi, Metsios, Twitchett, Koutedakis, & Wyon, 2012) plus, due to neural changes strength can be increased by 50% without an increase in muscle size (Ploutz, Tesch, Biro, & Dudley, 1994) or an alteration in selected thigh aesthetic components (Koutedakis & Sharp, 2004).

Central-Fatigue Hypothesis:

Over trained individuals show reduced outputs during voluntary muscular exercise. In testing it was shown that electrical stimulation of quadriceps of over trained individuals increased torque, whereas electrical stimulus had no effect upon the healthy subjects who were seemingly able to voluntarily fully activate their quadriceps (Koutedakis, Frischnecht, Vrbova, & Sharp, 1995).

Lecture 4: Strength Training and Training principles

Dance requires skill and fitness. Training stamina and strength alongside of skill is important and needs to be carefully planned.

Methodologies of training

1. Overloading: a training regime of greater intensity than accustomed in order to activate adaption and change, (Baechle & Earle, 2008, p. 380). Progressive overload/exercise stress is needed as levels of fitness components increase (Koutedakis & Sharp, 1999, p. 158).
2. Specificity: train what is needed for performance. This applies to force and velocity but not for muscle groups. Force-Velocity relationship; if speed is needed exercise loads should be low and velocity of movement high. If strength is needed, loads should be high and velocity low. (Komi & Hakkinen, 1988).
3. Individuality: training should be tailored to meet body type, muscle fibre type, gender, age, coordination etc. (Koutedakis & Sharp, 1999, p. 158).

4. Reversibility. ("Use it or lose it"). Detraining; the longer the training period the slower the detraining (Moritani & de Vries, 1979).

Principle Aims of Strength Training

- Facilitation of neural pathways.
- Increase muscle fibre reaction.
- Increase synchronisation of motor units during contraction/ improve coordination

(Baechle & Earle, 2008)

- To train to a higher level of strength than is needed in performance in order to be able to concentrate on artistry and technique and avoid exhaustion (Brinson & Dick, 2006, p. 65).

Strength Training Intensity Levels

Strength training begins with low intensity and high repetitions then gradually develops to high intensity and low repetitions. Effects on strength depend on training effort.

Effort	Effect
80-100%	Maximal strength
60-80%	Hypotrophy, explosive strength
40-60%	Speed strength, endurance strength
20-40%	Some strength endurance, no effect

Figure 9: *Strength-training intensities and training effects*

Adapted from Koutedakis and Sharp (1999, p. 127)

Supercompensation

A training session is a stimulus in order for the body to adapt. Adaption takes place 24-48 hours after training when glycogen stores are completely replenished and protein synthesis is at its highest. For supercompensation to take place it is necessary to overload the body. The next training session should take place when supercompensation has been reached and at this point testing, if desired, should be carried out.

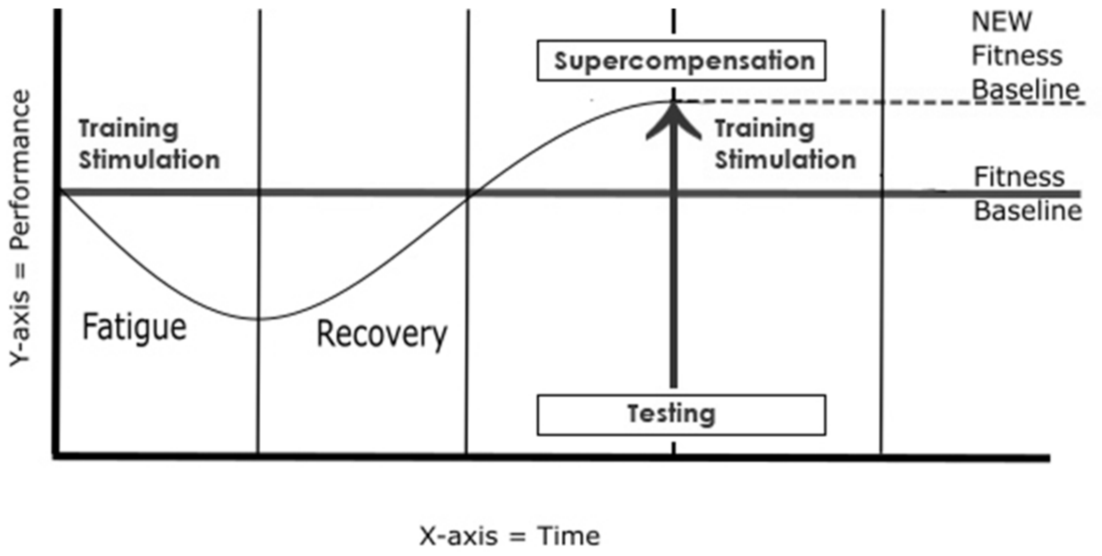

Figure 10: *Supercompensation and performance testing.*
Adapted from Komisarjevsky (2017)

Recovery

The recovery phase is 50% of the training. Here damaged muscles begin to repair; sarcomeres are produced making the muscle larger/longer and stronger. Post training; eat within 30 minutes to replenish glycogen, take 30 minutes for a mental re-cap, avoid alcohol and cigarettes, and protect immune system by avoiding socialising. Intense bouts of exercise can lower plasma glutamine levels which may impair immunity (Koutedakis & Sharp, 1999, pp. 206-207) & (Parry-Billings, et al., 1992).

Important points for training and recovery

- Warm-up and down (Brinson & Dick, 2006, pp. 52-54)
- Allow recovery time (Allen & Wyon, 2008, p. 8)
- Pay attention to nutrition and the quality, quantity and timing thereof (Allen & Wyon, 2008, p. 6)
- Never overload a damaged (sore) muscle
- Train upper and lower body alternately (Baechle & Earle, 2008, p. 391)
- Train left and right sides, antagonist and agonist muscles on different days.
- Use periodisation principles (Twitchett, Koutedakis, & Wyon, 2009)

Periodisation:

The occurrence of peak performance at a specific time is ensured through planned variation of intensity and volume in the total amount of exercise undertaken beforehand. Central to the plan are the individual, the goal and time for performance peak(s). Intensity begins low with volume high, progressing over time to High intensity with low volume (Baechle & Earle, 2008, p. 509). Training plans are divided into three cycles. Each cycle concentrates on a specific element of physical performance.

Peridisation cycles:

- Microcylce: e.g.1 week with an overall goal.
- Mesocycle: e.g. 3-6 months (containing two or more Microcycles) each mesocycle has training elements that correspond to the previous and succeeding mesocycle (Koutedakis & Sharp, 1999, p. 159).
- Macrocycle: e.g. 1 year (max 4 years and containing two or more Mesocycles) (Baechle & Earle, 2008, p. 509).

Overtraining

The body's 3 stages of response to exercise stress are shock, resistance and fatigue. Using principles of periodisation to support supercompensation and minimise fatigue is vital in order to avoid overtraining. An imbalance between exercise and rest cause overtraining, as do boredom and poor nutrition.

TABLE 21.8
THE OVERTRAINING SYNDROME: SYMPTOMS OF STALENESS

- Unexplained and persistant poor performance
- Disturbed mood states characterized by general fatigue, depression, and irritability
- Elevated resting pulse, painful muscles, and an increased susceptibility to upper respiratory infections and gastrointestinal disturbances
- Insominia
- Weight loss
- Overuse injuries

Figure 11: *Symptoms of overtraining*

(McArdle, Katch, & Katch, 1996, p. 412)

Lecture 5: Fitness and Health

Musculotendinous Unit

The key properties of all musculotendinous units affecting fitness and health are irritability, ability to develop tension, extensibility- from the tendons, and elasticity-from muscle. Muscle is energy demanding, whereas tendons are more energy efficient. The longer the tendons in an individual are the more energy efficient their movement.

Muscle Elasticity versus Flexibility

Collagenous membranes, the epimysium, surround the body´s more than 430 skeletal muscles (Baechle & Earle, 2008, p. 4) and are responsible for the elasticity of the muscle. The thicker the membranes the more elastic they are. Physical training/movement can increase the load-bearing capacity of the membranes (Baechle & Earle, 2008, p. 107)

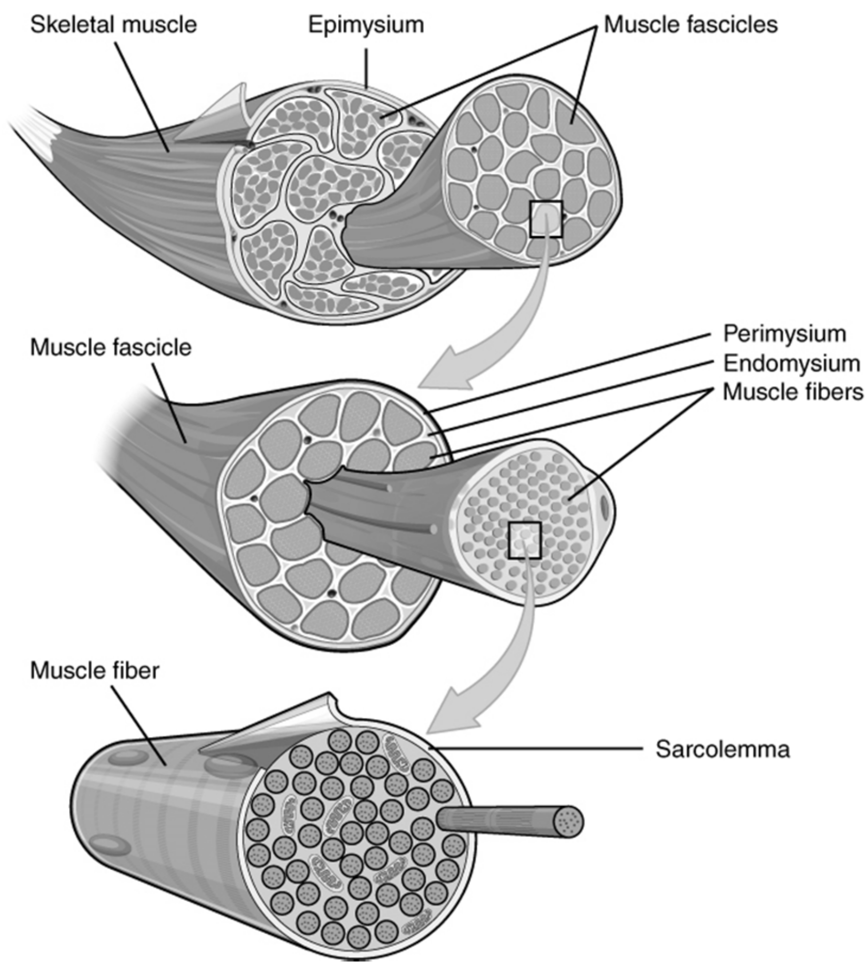

Figure 12*, The Connective Tissue Layers*

(Betts, et al., 2018)

Good flexibility is normally a sign of no adhesions or abnormalities either in or around the joint, or serious anatomical or muscular limitations (Koutedakis & Sharp, 1999, p. 128).

Factors affecting flexibility

- Joint Factors: Structure of bony surfaces and articular cartilage, joint-capsule laxity, ligaments, synovial fluid
- Muscle factors: fibrous connective tissue and muscle fat content, muscle /tendon length, stretch/relaxation techniques.
- General factors: age, gender, body type, fitness levels body fat, environmental factors, temperature, psychological stress.

(Koutedakis & Jamurtas, 2004, p. 130)

- Nervous system: reactions of the muscle spindle and Golgi organ (McArdle, Katch, & Katch, 1996, pp. 352-354).

Flexibility

Flexibility is crucial in complimenting muscular strength, building efficiency in movement, coordination, and avoiding injuries (Irvine, Redding, & Rafferty, 2011). Increased flexibility may put some dancers at risk of instability and injury due to poor joint stabilization (Hamilton, Hamilton, Marshall, & Molna, 1992) and (Desfor, 2003.) Inflexibility can result in higher risks of injury (Baechle & Earle, 2008)

Table 5.8 Advantages of muscle flexibility and joint mobility

- Protects joints
- Increases the range of possible skills
- Improves the quality of action
- Permits compensatory movements when situations demand
- Maintains a healthy musculature
- Prevents injury?

Figure 13*, Advantages of muscle flexibility and joint mobility*

(Koutedakis & Jamurtas, 2004, p. 134)

It is debateable as to whether highly flexible and/or highly inflexible physiques are more susceptible to injury than one another or physiques of "normal" flexibility (Deighan, 2005)

Flexibility versus muscular strength- Muscle Damage

Muscle damage appears especially in acute eccentric exercise. Here the muscle is stretched while working so it "breaks". Chronic eccentric exercise leads to new sarcomeres being built into the existing series to lengthen the muscle (and to strengthen it). The bout effect (rapid adaption) often takes place in order to protect the muscle during eccentric exercise. In this case, no damage takes place.

Phases of only chronic concentric exercise will lead to a loss in sarcomeres (shortening). Therefore, due to muscle shortening, subsequent eccentric exercise after a prolonged period of chronic concentric exercise makes the muscle more prone to damage. Research shows that alternating concentric and eccentric exercise can remove or reduce the bout effect. (Margaritelis, et al., 2015);

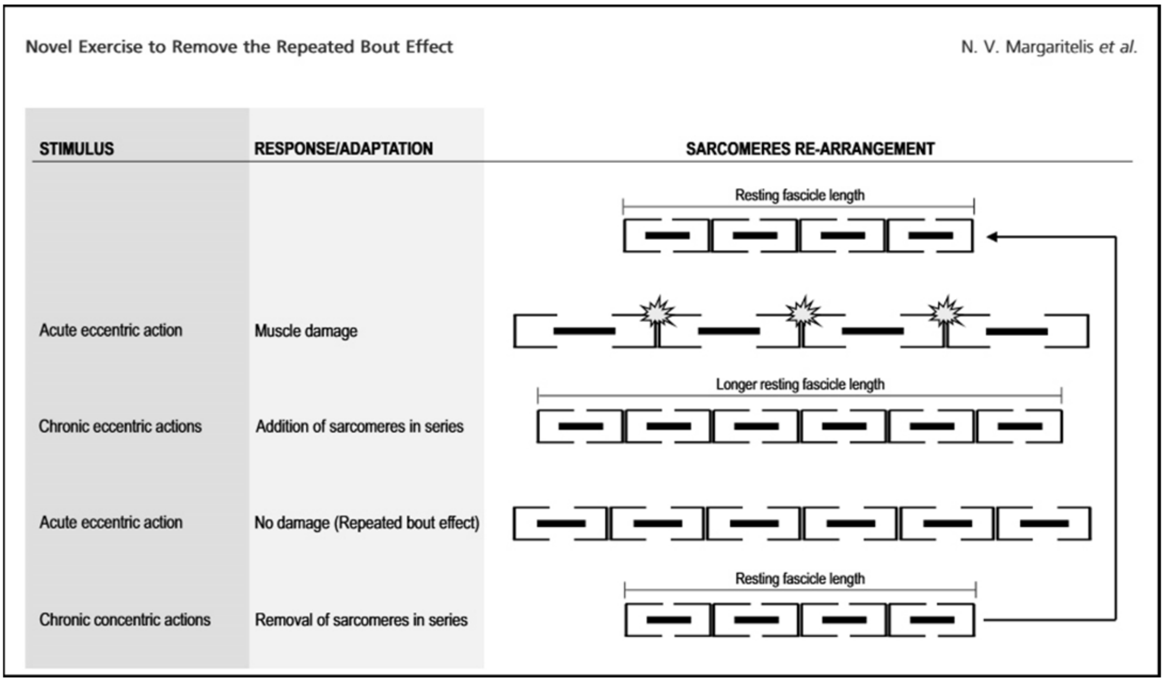

Figure 14: *Muscle damage and inflammation after eccentric exercise*

(Margaritelis, et al., 2015, p. 10)

<u>Post Exercise Muscle Damage Indices</u>

- Increased levels of CK (creatine kinase) and Mb (myoglobin) in the blood (Jamurtas, et al., 2000)
- DOM peaks 2nd day and can last for 3 to 4 days (McArdle, Katch, & Katch, 1996, pp. 448-449)
- ROM decreases particularly on 2nd and 3rd day (Jamurtas, et al., 2000)
- Decease in muscle performance for a week and most prominent on 2nd and 3rd day

<u>Recovery</u>

Biopsies undertaken during research showed that 2-3 weeks for muscle recovery is needed (Jones, Newham, Round, & Tolfree, 1986) however, affected units can maintain adaption for up to 6 months (Nosaka, Sakamoto, Newton, & Sacco, 2001).

Research shows that strength training and muscle damage through a weekly chronic and acute eccentric exercise session of 30 minutes is sufficient to induce health-promoting effects; a marked increase in muscle strength and performance, REE (resting energy expenditure), and lipid oxidation was shown, plus decreased insulin resistance and blood lipid profile. (Fatouros, et al., 2011). It was shown that lipid and lipoprotein profile was favourably affected by muscle damaging exercise. (Giakas, et al., 2008)

Body Fat

Body fat can be controlled with strength training. Females have more fat than males, even in childhood. In puberty the average girl gains about 5% of her body weight as fat (an increase of roughly 20 to 25% of total body weight) while a boy will lose maybe 2 to 3% of his body fat- meaning his body fat falls from about 18% to16% of his total body weight (Koutedakis & Sharp, 1999, p. 281). Much care must be taken to not pressure young female dancers to conform to an “ideal” body weight (Koutedakis & Sharp, 1999, p. 290).

After 25 years of age body fat increases in both sexes and genetics determine an individual’s amount of lipocyte cells where fat is stored.

Measuring Body Fat

Skinfold tests for measuring body fat are simple and accurate and should be undertaken over a longer period of time. The measurements should be carried out on the triceps, biceps, waist side and upper back close to spine.

Bones

The skeleton is in constant reconstruction. 5-7% of bone mass is renewed every week, thus every five months bone tissue of the skeleton is completely replaced (Simmel, 2009, p. 25).

Repetitive stress can violate the growth plate (epiphysis) and disturb further growth (Simmel, 2009, p. 207). Pain can be an indication of stress and disturbance to the epiphyseal fusion, e.g. in the hip, in highly physically active young people, (Wollman, Harries, & Fyfe, 1989, p. 720). Furthermore pain can be a result of the effects of an eating disorder on the epiphysis (Warren, 1990).

In (young) healthy individuals undertaking a reasonable amount of physical activity, exercise can increase bone density during growth, (Gunter, et al., 2008) and can protect the bones by supporting the maintenance of BMD (Nordström, & Tervo, & Hogstrom, 2011, p. 18)

<u>Muscle Imbalances and strength levels versus injuries</u>

Research implies that muscle imbalances are related to the severity of low-back injuries in dancers, while low levels of thigh torque are likely to be associated with the severity of pelvis, leg, knee, and foot injuries (Koutedakis, Khaloula, Pacy, Murphy, & Dunbar, 1997).

Conclusion

The information highlighted in this portfolio emphasises and explains the need for supplementary fitness training and healthy, balanced nutrition for dancers, plus clarifies how muscle fibre types define how individual dancers' physiques can react to training. The body (dancer) needs variety; in movement, daily schedule, surroundings, exercise and nutrition. Schooling including supplementary training of all 3 energy systems and information about the benefits thereof, plus the important role that nutrition plays in building and utilising these energy systems is important. Utilising the principles of periodisation can develop potential and benefit health and finances. Health should been regarded in dance education and professional settings as a working tool and harmful traditions within the dance world need to be discarded because:

> "Dancers must be fit enough to sustain the work they are required to do. With more power they can jump higher. With more strength the can resist injury better. With more aerobic endurance, they can concentrate better throughout the day. With more anaerobic endurance they can sustain high-energy dance sequences better. With appropriate flexibility and strength they can more easily reach and hold the positions required." (Brinson & Dick, 2006, p. 61)

Furthermore, they will have longer, more fulfilling careers and eventually pass on healthy information, based on scientific facts, to the next generation of dancers.

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