Effects of Supplemental Training on Fitness and Aesthetic Competence Parameters in Contemporary Dance

A Randomised Controlled Trial

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Within aesthetic sports such as figure skating and rhythmic gymnastics, physical fitness has been shown to have positive benefits on performance outcomes. Presently the link between physical fitness and aesthetic contemporary dance performance has not been demonstrated within an intervention study. In this study, 24 females engaged in contemporary dance (age 27 ± 5.9 yrs; height 165.3 ± 4.8 cm; weight 59.2 ± 7.6 kg) were recruited and randomly assigned to either an exercise (n = 12) or a control group (n = 12). Three dancers withdrew during the study. The intervention group completed a 6-week conditioning programme comprising two 1-hr sessions of circuit and vibration training per week. The circuit training focused on local muscular endurance and aerobic conditioning and vibration training protocol concentrated on power. Repeated measures ANOVA revealed significant increases for the conditioning group in lower body muscular power (11%), upper body muscular endurance (22%), aerobic fitness (11%), and aesthetic competence (12%) ($p < 0.05$). The control group reported decreases in all the fitness parameters with the exception of aerobic fitness as well as a decrease in aesthetic competence (7%). A 6-week circuit and vibration training programme, which supplemented normal dance commitments, revealed significant increases in selected fitness components and a concomitant increase in aesthetic competence in contemporary professional and student dancers. *Med Probl Perform Art* 2012; 27(1):3–8.

The majority of studies in contemporary dance have made observations about the physical fitness levels of contemporary dancers, such as aerobic fitness,[1] anaerobic power,[2] and muscular strength.[3] These studies demonstrated that dancers, both professionals and students, have reduced fitness levels compared to athletes. In other aesthetic-based disciplines, such as rhythmic gymnastics, increases in selected fitness levels, such as strength and flexibility, are associated with significant improvements in technique,[4] which in turn can affect overall performance. However, there is a paucity of data regarding the effectiveness of supplementary conditioning training on aesthetic competence (AC) and fitness levels in contemporary dance. To our knowledge, only two studies have investigated the effects of increased fitness levels (only one via appropriately designed interventions) on selected aspects of contemporary dance. These available data suggest that increases in muscular strength and power have beneficial effects on jump ability[5] and overall performance.[6] However, it has been suggested that these data can only be considered preliminary, since they both used an aesthetic assessment tool which was not previously assessed for validity or reliability. For this reason, it is necessary to further investigate the effects of supplemental conditioning training on contemporary dance performance using appropriate methodological designs and reliable techniques.[7]

A recently published study by our group revealed that aesthetic competence of professional and student contemporary dancers, assessed by a reliable AC tool, is associated with higher levels of lower body muscular power and upper body muscular endurance.[7] Therefore, developing exercise interventions to specifically train these two physiological aspects may further improve AC in dancers.

The physiological effects of resistance training on muscular power and endurance are well documented.[8] The effects of such training are related to the type of exercise used, its intensity, and its volume.[9] Circuit training (CT), a series of exercises arranged consecutively in 9 to 12 stations with 15- to 45-second workouts and little (15 to 30 seconds) or no rest in between, has been shown to significantly improve aerobic capacity [10] and muscular fitness.[11] CT may be performed with exercise machines, hand-held weights, elastic resistance, or any combination. The benefits of whole-body vibration (WBV)

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TABLE 1. Participants' Characteristics at Baseline*

Group	No.	Age (yrs)	Height (cm)	Weight (kg)	%BF
Conditioning	12	27 ± 4.3	163 ± 5.5	56.4 ± 6.7	19.7 ± 3.2
Control	9	27 ± 7.9	165.4 ± 4.6	58.3 ± 7.4	19.3 ± 1.6

*No significant differences between groups.

training have been shown in disease, sedentary, and exercising populations,[12–14] while relevant studies on dancers[15,16] have shown increased power and active flexibility without increasing muscle circumference, an important aspect when in dance aesthetics. Previous research has shown that the length of time required for each exercise session is much shorter than traditional supplemental training sessions.[17,18] This enables supplemental vibration training to be programmed into training/rehearsal schedules that typically last 6 to 8 hours a day without significantly increasing the workload.

Therefore, the main aim of the present study was to investigate the effects of a supplementary 6-week CT and WBV training programme on selected fitness-related parameters, such as lower body muscular power, upper body muscular endurance, aerobic fitness, and AC in female contemporary dancers.

METHODS

The purpose of the present randomized controlled clinical trial was to examine the effects of a 6-week supplementary CT and WBV programme on fitness-related parameters and AC in contemporary dancers. Using the closed-envelope method, participants were randomly assigned to either a conditioning or a control group. The conditioning group undertook the 6-week exercise training programme, while the control group completed two extra 1-hour contemporary dance technique classes per week (equivalent time exposure as the conditioning group). During the entire period, both groups received the same amount of dance practice.

Data were collected during the weeks just before and after the conditioning and included: anthropometry and body composition, lower body muscular power, upper body muscular endurance, aerobic fitness, assessed via validated procedures,[19] and an AC test comprised of 90 seconds of a choreographed contemporary dance routine.[7] In order to investigate the effects of our training protocol on AC and selected fitness parameters, dancers were instructed to follow their normal lifestyle and to participate in no additional exercise training beyond their regular dance training prior and during the 6-week period. The authors' institution's ethics committee approved the study.

Participants

Fourteen female contemporary dance students in preprofessional training and 10 professional dancers were recruited from a dance conservatoire final-year performance group and a full-time dance company during the spring term. A mixed group was used as the authors tried to ensure that the dance training load of the participants was similar, and the dance conservatoire and company approached to participate in this study had very similar class and rehearsal training time. Three participants from the control group dropped out midway through the study, resulting in 12 participants in the conditioning group and 9 in the control group (Table 1).

Dancers were excluded from the study if: 1) they presented a confirmed injury and/or eating disorder, or 2) they were undertaking other forms of sports activities. Each of the inclusion criteria was determined by responses to a specifically modified medical questionnaire (Par-Q). Written informed consents were obtained from all participants after full verbal and written explanation of the data collection procedures.

Data Collection

All testing was completed on the same day and with the following order: 1) fitness assessments and 2) AC test. To avoid fatigue, an interval of 3 hours was allowed between the fitness and AC tests. Pre- and post-testing sessions occurred within 1 week before and after the 6-week conditioning period. All assessments were conducted after 15 to 20 minutes of a tailored warm-up routine. The fitness tests followed the British Association of Sport and Exercise Science guidelines for dancers.[19]

Anthropometry and Body Composition

Standing height was measured to the nearest 0.5 cm using a Seca stadiometer 208 (Hamburg, Germany), with the participants in bare feet and their heads positioned at the Frankfort horizontal plane. Total body mass was measured to the nearest 0.5 kg using a Seca beam balance 710 (Hamburg, Germany). Percentage body fat (%BF) was estimated from the mean of three readings per site according to the four-sites formula of Durnin and Womersley where the sum of the triceps, subscapular, suprailiac, and calf skinfolds were needed to calculate body density prior to using the Siri equation to determine %BF; Harpenden callipers were used.

Muscular Power

Muscular power of the lower extremity was assessed by a standing vertical jump (SVJ) that has been found to correlate well with lower body muscle power.[5] Participants were barefoot and were asked to assume the dance first position (heels together and hips externally rotated) on a jump meter (Takei Yashiroda, Japan); they were then instructed to perform a *demi-plié* (half-squat) and immediately jump as high as possible off both feet keeping heels together, hips externally rotated, and pointed feet (a dance *sauté*); the arms remained at the side throughout the jump sequence. Participants were asked to repeat the test three times and the highest score was recorded.

Muscular Endurance

Upper body muscular endurance was measured by the number of complete press-ups completed in a 1-minute period.[19,20] This test was used since it has been found to be a valid and reliable indicator of the upper body muscular endurance.[20] It was administered with the participants in the modified knee press-ups position. A complete press-up was achieved when the chest was lowered so the arms achieved a 90° bend and then lifted until the arms were straight.

Aerobic Capacity

The aerobic capacity of dancers was tested using the validated Dance Aerobic Fitness Test (DAFT).[21] The test consists of five progressively demanding stages, lasting 4 minutes each, for a total of 20 minutes. Each stage was a contemporary dance sequence, which increased in intensity and speed at each stage. Before the test, each subject underwent a familiarization process and was introduced to the tempo of each stage and the test termination criteria.[21] Dancers were fitted with a Polar heart rate (HR) monitor (Kempele, Finland). The mean HR of the participants during the last minute of the last stage was calculated from the downloaded HR data.[21] The final stage has a mean aerobic demand of 46 $mL \cdot kg^{-1} \cdot min^{-1}$ for females and is representative of the mean peak O_2 demand during contemporary dance performance.[22]

Contemporary Dance Aesthetic Competence Test

A recently developed reliable dance aesthetic competence test[7] was employed. Participants were asked to learn the short dance sequence (1 min 30 secs) within a 20-minute period. They performed the sequence pre- and post-conditioning with each trial being video-recorded. An experienced female contemporary dance teacher marked each trial using the seven criteria in the AC tool[7] (i.e., control of movement; spatial skills; accuracy of movement; technique; dynamics, timing, and rhythmical accuracy; performance qualities; overall performance). Each criterion could be scored from 1 (minimum score) to 10 (maximum score) with a possible total score of 70. The marker was blind as to the groups the participants had been allocated and order of the videoed dance pieces (pre or post trial).

Training Programme

The conditioning training took place at the participants' workplace, which was equipped with the required facilities (i.e., vibration platform, free weights, jump ropes, mats). Training was organised twice a week and each training session lasted approximately 1 hour. Warm up and cool down were performed respectively before and after each training session. The conditioning comprised circuit training (CT) followed by whole-body vibration training (WBV). A rest time of 10 minutes was set between CT and WBV. For the total time of the training period, participants were supervised and always guided by the same member of the research team.

A dance-specific CT programme was designed, according to existing protocols. This consisted of lower and upper body exercises, organised 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, heel-rises in dance first position, deep squats in dance second position, chest press exercises (with free weights of 0.5 kg each), and plank. Each station was a continuous 30-sec exercise, during which the dancers where instructed to perform as many repetitions as possible. A maximum transitory time of 10 sec was allowed between each station. The total time for each circuit was 6 min 50 sec (including the rest between each station). Dancers were instructed to perform a total of four circuits. Each training session was supervised by the same exercise instructor in order to ensure that participants were exercising with the correct technique.

The WBV training protocol used in this study was a dance-modified (i.e., dance-specific static positions) version of an existing protocol.[23] It involved three sets, lasting 40 seconds each, of six static positions: 1) squat position with feet in dance first position.; 2) plank position (elbow flexed on the floor and feet on platform); 3) lunge position (right and left leg); 4) press up position, 90° bend at the elbows; 5) calf position, feet in *relevé* (heel-rise) with knees slightly bent; 6) hamstring position, bent over at waist, with knees slightly bent and hamstrings tensed. The rest between each set was 2 minutes. The frequency of the vibration platform was set at 35 Hz and amplitude at 2.5 mm according to previously used protocols.[23] The WBV training took place twice a week following the CT, in the same studio.

Statistical Analysis

Routine pre-analyses were conducted using the Kolmogorov-Smirnov normality tests to assess the normal distribution of the studied variables. One-way ANOVA was used to investigate for significant baseline differences between the two groups. The differences between pre- and post-test data for both groups (conditioning vs. control) were assessed using two-way repeated measures analyses of variance (RMANOVA) with "group" (conditioning, control) and "time" (pre, post assessments) as independent factors. Statistical analysis was performed with SPSS software (version 13.0, SPSS Inc., Chicago, IL) while the level of significance was set at $p < 0.05$.

RESULTS

At baseline (prior to the conditioning), no significant differences were noted between the conditioning and control

TABLE 2. Pre and Post Data for the Conditioning and Control Groups

Group	Parameter	Pre (mean ±sd)	Post (mean ±sd)
Conditioning (n=12)	Press ups ($n.min^{-1}$)	29 ± 7.24	37 ± 12.34
	SVJ (cm)	29.9 ± 5.81	33.6 ± 3.38
	Aerobic ($b.min^{-1}$at $46ml.kg^{-1}.min^{-1}$)	196 ± 9.71	177 ± 15.5
	Aesthetic Competence	38 ± 12.92	43 ± 6.34
Control (n=9)	Press ups ($n.min^{-1}$)	30 ± 6.29	30 ± 2.12
	SVJ (cm)	30.3 ± 4.39	28.5 ± 3.32
	Aerobic ($b.min^{-1}$at $46ml.kg^{-1}.min^{-1}$)	196 ± 3.59	185 ± 7.07
	Aesthetic Competence	45 ± 6.22	42 ± 3.34

	Conditioning (*n* = 12)		Control (*n* = 9)	
Parameter	**Pre**	**Post**	**Pre**	**Post**
Press-ups (n/min)	29 ± 7.24	37 ±12.34	30 ± 6.29	30 ± 2.12
Standing vertical jump (cm)	29.9 ± 5.81	33.6 ± 3.38	30.3 ± 4.39	28.5 ± 3.32
Aerobic (beats/min at 46 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$)	196 ± 9.71	177 ± 15.5	196 ± 3.59	185 ± 7.07
Aesthetic competence	38 ± 12.92	43 ± 6.34	45 ± 6.22	42 ± 3.34

Data presented as mean ± SD.

groups for demographics (Table 1), anthropometric characteristics, fitness parameters, or AC scores.

Table 2 depicts the baseline and post-conditioning results for all physical fitness parameters and AC for both groups. For the conditioning group, RMANOVA revealed significant increases (pre vs. post) in standing vertical jump, press-ups, aerobic fitness (decreased HR at 46 $mL \cdot kg^{-1} \cdot min^{-1}$) and AC ($p < 0.05$) (Fig. 1). The control group increased aerobic fitness, though the other parameters either decreased (SVJ and AC) or remained unchanged (muscular endurance).

DISCUSSION

The aim of the present randomised controlled trial was to examine the effects of a 6-week circuit (CT) and vibration (WBV) training programme on fitness-related parameters and aesthetic competence (AC) in contemporary dancers. The main result was that for the conditioning group, supplementary exercise training significantly increased selected fitness components (lower body muscular power, upper body muscular endurance, and aerobic fitness) with simultaneous increases in aesthetic competency of the dancers.

Preliminary published data revealed that aerobic and strength training improves overall dance and jump performance of contemporary dance students.[5,6] The present findings confirm these preliminary data, suggesting that the aesthetic competency of dancers benefits from enhanced physical fitness levels such as lower body muscular power, upper body muscular endurance, and aerobic capacity. Video analysis of contemporary dance performances[24] has shown the importance of muscular power and endurance. During a dance performance, dancers have been observed carrying out an average of 2 jumps/min and 0.14 lifts/min (partner at shoulder height or higher) as well as 8 plies/min and 0.8/min transitory movements from stand to floor and vice versa, which specifically tax muscular power and endurance. Although dance is an intermittent type of exercise,[25] aerobic fitness is necessary for dancers since low levels of aerobic fitness have been associated with increased fatigue[26] and increased recovery time between high-intensity bouts,[27] which in turn have negative impacts on overall performance such as reduced neuromuscular control[28] and mental concentration[29] and higher injury rates.[30]

The observed increases in aerobic fitness are most likely to be attributed to the circuit training, since previous research[12] has revealed that following a 12-week 25-minute CT program, which alternated local muscular endurance with global endurance exercises 3 days per week, participants significantly improved their aerobic capacity together with upper muscular endurance. Although our conditioning study lasted 6 weeks only, similar improvements were observed.

Previous studies have shown that whole-body vibration training (WBV) enhances strength and power capabilities[18] and the lower limb performance in ballet and contemporary dancers,[15,16,31] which explain the increases for standing vertical jump observed in the conditioning group. A reason for this phenomenon can be explained by the fact that WBV elicits both concentric and eccentric contractions; hence, the enhancement of muscular power occur via potentiating the neuromuscular system, whereby stimulations of muscle spindles results in reflex activations of motor neurons with increased spatial recruitments.[32] Increases in upper body muscular endurance were observed in the conditioning group only. Nash and colleagues[33] reported similar findings following a 4-month CT program using high-speed, low-resistance arm exercise circuit resistance training with improvements in muscle strength, endurance, and anaerobic power.

Previous studies investigating the effects of supplementary exercise training on contemporary dance relied on a subjective aesthetic evaluation.[5,6] As such, they can only be considered preliminary.[7] The employment of a reliable aesthetic

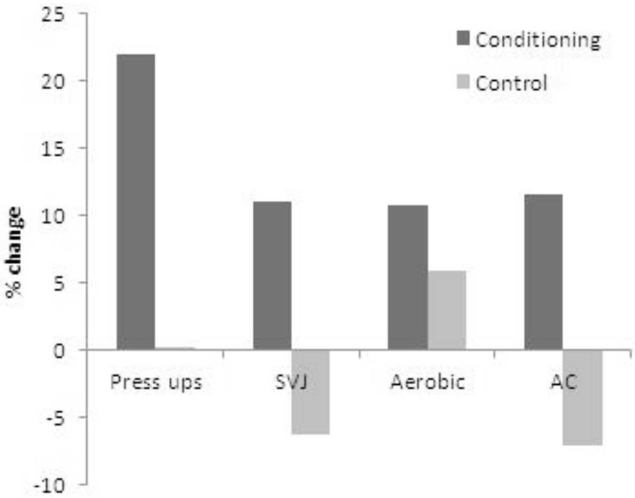

FIGURE 1. Percent changes in study parameters for the conditioning and control groups.

competence tool and pre- and post-fitness testing surpasses this limitation, and therefore, it is reasonable to suggest that our findings confirm these previously published results.

The control group exhibited no changes in AC, upper body muscular endurance, and aerobic fitness during the 6 weeks. This suggests that dance training is not sufficient enough to overload the aerobic/anaerobic and musculoskeletal systems[25,34] and thus to produce physiological adaptations that will enhance each individual fitness component.

The present data suggest that a 6-week conditioning is long enough to elicit significant adaptations in both physical fitness and aesthetic indices, as this is on top of a daily schedule that incorporates 6 to 8 hours of dancing. The time period is also more realistic of the time available for companies to integrate supplemental training between performance periods. A limitation of the present study is the employment of a mixed sample of contemporary dancers, which does not allow us to draw conclusions about whether the effects of supplementary fitness training on aesthetic competency in professional and student dancers might be different. Further research is needed to investigate the effects of supplementary training over injury rate and severity.

The present study significantly contributes to the existing open debate whether dancers, seen as performing or aesthetic athletes,[19,35,36] would further benefit from enhanced physical fitness levels equally to other athletes. Dance institutions and companies by incorporating supplementary training, such as the present study, will help increase selected fitness levels of dancers as well as improve and/or maintain their aesthetic competence. This will help bridge the observed fitness gap between performance preparation (class and rehearsals) and performance periods.[34] The incorporation of supplemental training into the dancers' schedule must take into account present work load, which can involve 6 to 8 hrs/day of exercise at varying intensities already.[37] Training sessions need to be time-tabled at the end of the day, especially if WBV is being used, 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; otherwise a whole-body focus will suffice, allowing the training during rehearsal periods to provide specificity. The use of WBV training 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.

CONCLUSION

A 6-week supplemental training programme that incorporated circuit and WBV training twice a week had a significantly beneficial effect on both physical fitness indices and aesthetic competency for high skilled contemporary dancers.

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