2014-08-01

A Comparison of Physiological and Psychological Characteristics Among Sport Baton Twirlers, Competitive Cheerleaders, and Modern Dancers

Melissa Marcus
University of Miami, fsutwrlr1@aol.com

UNIVERSITY OF MIAMI

A COMPARISON OF PHYSIOLOGICAL AND PSYCHOLOGICAL CHARACTERISTICS AMONG SPORT BATON TWIRLERS, COMPETITIVE CHEERLEADERS AND MODERN DANCERS

By

Melissa Marcus

A DISSERTATION

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Doctor of Philosophy

Coral Gables, Florida

August 2014

UNIVERSITY OF MIAMI

A dissertation submitted in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy

A COMPARISON OF PHYSIOLOGICAL AND PSYCHOLOGICAL CHARACTERISTICS AMONG SPORT BATON TWIRLERS, COMPETITIVE CHEERLEADERS AND MODERN DANCERS

Melissa Marcus

Approved:

_____
Arlette C. Perry, Ph.D.
Professor and Chairperson of
Kinesiology and Sport Sciences

_____
Kevin Allen Jacobs, Ph.D.
Associate Professor of
Kinesiology and Sport Sciences

_____
Bobby Lee Robertson, Ed.D.
Professor of Kinesiology
and Sport Sciences

_____
M. Brian Blake, Ph.D.
Dean of the Graduate School

_____
Soyeon Ahn, Ph.D.
Associate Professor of
Educational and Psychological Studies

MARCUS, MELISSA (Ph.D., Exercise Physiology)

A Comparison of Physiological and Psychological Characteristics Among Sport Baton Twirlers, Competitive Cheerleaders, and Modern Dancers (August 2014)

Abstract of a dissertation at the University of Miami.

Dissertation supervised by Professor Arlette Perry.
No. of pages in text. (23)

Baton twirling is a competitive sport that has grown in popularity throughout the United States and around the world, with the hope of being recognized by the International Olympic Committee as a sport worthy of Olympic competition. Unfortunately, a paucity of research exists on physical characteristics of sport baton twirlers. The present study examined anthropometric, physical, and psychological characteristics of sport baton twirlers (n = 18) in comparison to competitive cheerleaders (n = 20) and modern dancers (n = 18) between the ages of 12 and 23. An Analysis of Variance (ANOVA) with a Tukey's post hoc test for the significant effect showed that sport baton twirlers were taller than competitive cheerleaders (p = 0.011) and demonstrated a trend toward weighing more (p = 0.063). Upon controlling for weight and height, an Analysis of Covariance (ANCOVA) with Fisher's least significant difference (LSD) post hoc test showed that sport baton twirlers completed a significantly higher number of alternate hand wall tosses than competitive cheerleaders and modern dancers ($p < 0.001$ for both), scored higher on the Harvard step test fitness index than competitive cheerleaders (p = 0.028) and modern dancers (p = 0.003), possessed greater right handgrip strength than both competitive cheerleaders and modern dancers ($p < 0.001$ for both), and possessed greater left handgrip strength than competitive cheerleaders (p = 0.010) and modern dancers (p = 0.07). The same analysis also showed that modern

dancers had significantly greater hamstring flexibility than sport baton twirlers (p = 0.007) and performed significantly better than competitive cheerleaders in the push-up fitness test ($p < 0.001$). ANCOVA results showed no differences in self-reported questionnaires for psychological measures among the three sport groups. Our findings showed significant differences in anthropometric and physical characteristics in sport baton twirlers compared to modern dancers and competitive cheerleaders. These finding may have important implications for training and conditioning requirements specific to the three athletic groups. Furthermore, these differences observed among the three sport groups may be due to different types of training.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Baton Twirling is a competitive sport that has demonstrated tremendous growth and popularity throughout the United States and around the world during the last 50 years. Although baton twirlers demonstrate strength, flexibility, dexterity, endurance, and a high level of technical skill and coordination, very little information exists regarding their physical fitness levels (World Baton Twirling Federation, 2012).

Competitive cheerleading and modern dance are two sports possessing similar physiological profiles to that of baton twirling. Cheerleading combines stunts, gymnastic tumbling, dance, and cheers to showcase the strength, coordination, and agility required for quality performance (SooHoo et al., 2005). Modern dance is a freestyle type of dance that is based upon movements and the expression of feelings (Koutedakis et al., 2007). However, the physical nature of modern dance may require a more athletic background, with greater levels of physical fitness demanded for successful performance (Koutedakis et al., 2007).

Historically, cheerleading and modern dancing were not considered athletic activities, however since becoming internationally competitive events, research has shown these sports require high degrees of flexibility, strength, coordination, and physical fitness levels concomitant with low body weight to be successful (Goodwin et al., 2004, Padfield et al., 1993, Thomas et al., 2004, Thompson and Digsby, 2004). Competitive cheerleaders possess aerobic fitness levels similar to other athletes including basketball players, swimmers, tennis players, gymnasts, and volleyball players, while modern dancers show significantly higher fitness levels than untrained females of similar

age (Thomas et al., 2004, Padfield et al., 1993, Baldari et al., 2001, Koutedakis et al., 2007). Research also shows that participation in these sports results in considerable improvements in self-esteem, however, they do place strong emphasis on the desire to be thin for aesthetic and performance reasons which may put these athletes at greater risk of developing eating disorders (Davison et al., 2002, Torres-McGehee et al., 2009, Thompson and Digsby, 2004).

The greater performance expectations of female athletes in competitive cheerleading and modern dance have led to considerably more interest and research conducted in their respective sports. Since there is no published scientific research specific to sport baton twirling it would be important to gain more knowledge of the physical characteristics necessary for achievement in this sport. Furthermore, it would be interesting to examine whether physical and psychological characteristics observed in baton twirling are similar to comparable sports, such as competitive cheerleading and modern dancing or whether all three sports require varying athletic skills.

The purpose of this study is to examine age and anthropometric characteristics and physical fitness levels including flexibility, hand-eye coordination, upper and lower body muscular strength and endurance, and aerobic fitness in sport baton twirlers in comparison to competitive cheerleaders and modern dancers. Furthermore, this study will examine disordered eating, body image, and self-esteem in aforementioned athletes to compare and contrast psychological characteristics among the three groups.

CHAPTER 2

METHODS

Experimental Approach to the Problem

A series of one-way Analysis of Variances (ANOVA) were performed to determine whether significant differences exist among sport baton twirlers, competitive cheerleaders, and modern dancers on measures of age and anthropometric characteristics that were widely used in the previous literature for similar aesthetic sports. Tests of correlations were performed to determine if there were significant relationships among any pair of variables. Based upon the correlation matrix and results of the anthropometric data, weight and height were controlled for when examining physical fitness and psychological variables in a series of one-way Analysis of Covariances (ANCOVA). It was hypothesized that sport baton twirlers may demonstrate similar anthropometric characteristics, but greater upper body flexibility, hand-eye coordination, and hand and forearm strength in comparison to competitive cheerleaders and modern dancers. It was unknown whether baton twirlers would have lower self-esteem, body image concerns, or be at greater risk for disordered eating than their athletic counterparts.

Subjects

Fifty-six female subjects (n = 18 for sport baton twirlers, n = 20 for competitive cheerleaders, n = 18 for modern dancers) volunteered to participate in this study. Participants included female sport baton twirlers in the South Florida area, competitive cheerleaders from an all-star cheerleading studio in Miami, and modern dancers from

dance companies in Miami, between the ages of 12 and 23. Age range was determined using the minimum age requirement to compete in international sport baton twirling events and the age in which most athletes retire from the sport after the completion of college. In order to qualify for participation in this study, sport baton twirlers, competitive cheerleaders, and modern dancers were required to have state, regional, or national competition experience. Written informed consent was obtained from participants in accordance with the guidelines set forth by the University of Miami Institutional Review Board. Since many participants were under the age of 18, they were required to receive parental consent and complete a minor assent form. All participants were required to fill out a self-administered medical form prior to testing. Subjects who displayed medical problems, including cardiovascular disease, heart valve problems, pulmonary problems, or orthopedic limitations which may affect performance, were excluded from the study. All participants were apparently healthy and approved for participation in the study.

Age and Anthropometry

Age was determined by self-report. Weight was measured on a scale, while height was measured by marking the head level position on a wall using a measuring tape from the ground to the marked point. Body mass index (BMI) was calculated using the weight and height measurements recorded. Using a Lange skinfold caliper, three skinfold sites were measured, i.e. triceps, suprailiac, and thigh and percent body fat was calculated from body density using the formula developed by Jackson and Pollack (ACSM, 2010).

Physical Fitness Testing

Flexibility was measured using the sit and reach test, trunk rotation test, and shoulder and wrist elevation test. The sit and reach test, which measures lower back and hamstring flexibility, was performed with the subject sitting with a yardstick between their legs, while the legs were extended at right angles to a taped line on the floor at the 15 inch mark. The participant reached forward with both hands as far as possible and held the position for approximately two seconds with the average of two trials recorded (YMCA, 2000).

Trunk and shoulder flexibility was measured using the trunk rotation test. Subjects stood on a taped line on the floor with their feet shoulder width apart and a lightweight wooden bar placed evenly across the shoulders while rotating as far as possible to the left or right side with their knees straight. At the end of the rotation movement, a plumb bob, attached to the ends of the bar was steadied and then dropped to the floor. The degree of rotation was measured using a long-arm goniometer (Evans et al., 2006).

Flexibility of the shoulder and wrist was measured with the subject lying prone on the floor, with their arms fully extended raising the stick as high as possible. The vertical distance from the floor to the stick was measured to the nearest half an inch. The arm length from the acromion process to the tip of the longest finger was recorded and subtracted from the longest vertical distance recorded after three trials (Johnson, 1986).

Hand-eye coordination was measured using the alternate hand wall toss test. While standing three feet from the wall, a tennis ball was thrown from one hand in an

underhand motion and caught in the opposite hand as many times as possible for 30 seconds, and the maximum number of successful catches was recorded (Top End Sports, 2012).

Lower body power was measured using the vertical jump test, which is also known as the Sargent jump test. Subjects stood with their feet planted on the floor while extending their arm as high as possible and marking the wall with their chalked fingertips (M1). From a static position, the subject jumped as high as possible and marked the wall again (M2). The distance between M1 and M2 was measured and the average of three trials was recorded (Sargent, 1921).

The push-up fitness test, which measures upper body muscular endurance, was performed in the modified "knee push-up" position. This entails bending the arms while lowering the body until the chin touches the mat while keeping the back straight and then pushing up into a straight arm position as many consecutive times as possible until exhaustion (ACSM, 2010). Abdominal muscular endurance was measured using the sit-up fitness test, also known as the curl-up test. While in a supine position on a mat with knees bent at a 90 degree angle and arms to the side, palms facing down, subjects performed controlled curl ups lifting the shoulder blades off the mat. Subjects were asked to perform as many sit-ups as possible without pausing until exhaustion while the maximum number of sit-ups was recorded (ACSM, 2010).

Aerobic fitness was measured using the Harvard step test. Participants stepped up and down on a 20 inch platform/step at a rate of 30 steps per minute for five minutes. Heart rate was calculated with the subject seated at 1 to 1.5 minutes, 2 to 2.5 minutes, and 3 to 3.5 minutes after completion of each phase of the test. The fitness index was

calculated multiplying the test duration in seconds by 100 divided by the sum of heart rates ($bts \cdot min^{-1}$) taken after three-30 second intervals at 1 to 1.5 minutes, 2 to 2.5 minutes, and 3 to 3.5 minutes. The sum of the three heart rates was multiplied by two for a final fitness index score (Brouha, 1943).

Isometric strength of the hand and forearm muscles was measured with a Lafayette handgrip dynamometer (Lafayette Instrument Co., Lafayette, IN) while the elbow was bent at a 90-degree angle to the side of, but not against the body. The dynamometer was squeezed to maximum level for five seconds, while the average of three trials, each separated by 15 second intervals, was recorded (Davis, 2004).

Self-reported Questionnaires for Psychological Measures

Subjects completed three self-reported questionnaires; the Eating Attitudes Test – 26 (Garner et al., 1982), the Body Shape Questionnaire – 34 (Cooper et al., 1986), and the Rosenberg self-esteem scale (Rosenberg, 1989).

The Eating Attitudes Test (EAT-26) is a 26-item self-report instrument used to measure food preoccupation, eating behaviors, vomiting and laxative use, and pressure from others to gain weight. The questions are answered on a 6-point Likert scale ranging from 6 (*always*) to 1 (*never*) (Doninger et al., 2005). A score of ≥ 20 indicates a high level of concern about dieting, body weight, or problematic eating behaviors and is correlated with a higher risk for developing an eating disorder (Garner et al., 1982)

The Body Shape Questionnaire – 34 (BSQ) is a 34-item self-report questionnaire based on a five-point Likert scale that relates body shape to body image symptoms. These symptoms include preoccupation with weight and shape, public embarrassment or avoidance of activity or exposure due to self-consciousness, and feelings of fatness after

eating (McConnell et al., 2000). Scoring is divided into four categories: not concerned about body shape (<81), slightly concerned about body shape (81-110), moderately concerned about body shape (111-140), and marked concern about body shape (>140) (Espina et al., 2002).

The Rosenberg self-esteem scale consists of 10 items measured on a five-point Likert scale that is used to assess global self-esteem (Hein et al., 2007). Five questions on the scale are positively worded, while the other five items are negatively worded. Scores between 15 and 25 indicate average self-esteem, while scores <15 indicate low self-esteem (Rosenberg, 1989).

Statistical Analyses

Descriptive statistics were first computed for all age and anthropometric measures, physical fitness tests, and self-reported questionnaires, separately by each group (sport baton twirlers, competitive cheerleaders, and modern dancers). Variables were then tested for the underlying assumptions for one-way ANOVA and ANCOVA: normality of errors, independence of errors, and homogeneity of error variances across groups. If the normality of errors was not met, a logarithmic transformation of non-normal measures was done. No transformations were reflected in the tables. If the normality of errors after transformation is still violated due to obvious outlier(s), a sensitivity analysis was conducted to see whether statistical inferences differ depending upon outlier(s). If the outlier(s) did not affect the significance, it was removed. If homogeneity of error variances was not met, the level of significance was set at 0.025 ($\alpha \leq 0.025$) to decrease the probability of making a Type I error. For instance, since there was a lack of homogeneity of error variance among the three sport groups for the sit and

reach test and fitness index scores from the Harvard step test, a significance level was set at 0.025 to examine the significant effect in the subsequent statistical analysis.

A series of separate one-way ANOVAs were conducted to determine whether there were significant differences in age and anthropometric variables among the three sport groups (sport baton twirlers, competitive cheerleaders, and modern dancers). For the variable with a significant main effect, Tukey's post hoc analysis was performed to determine which specific group differs. Tests of correlations were conducted to determine significance in the relationships among all measured variables. Based upon inspection of the correlation matrix and results of the anthropometric data, weight and height were controlled for when examining physical fitness and psychological variables in a series of separate one-way ANCOVAs. After conducting the ANCOVA analyses, Fisher's Least Significant Difference (LSD) was used as a post-hoc test to determine where significant differences occurred among the three groups. Statistical significance was determined at an alpha of 0.05 for all analyses, except for the sit and reach test and the fitness index scores for the Harvard step test, where an alpha of 0.025 was used. All statistical analyses were completed using the Statistical Package for the Social Sciences, version 22.

CHAPTER 3

RESULTS

The descriptive statistics and results from ANOVA comparing age and anthropometric characteristics among sport baton twirlers, competitive cheerleaders, and modern dancers are presented in Table 1. Although no significant differences were found for age, weight, BMI, or body fat among the three sport groups, a significant difference was found for height among the three groups ($p = 0.013$). Tukey's post hoc analysis showed that sport baton twirlers were significantly taller than competitive cheerleaders ($p = 0.011$). The same post hoc analysis also showed a trend toward significance for sport baton twirlers being heavier than modern dancers ($p = 0.063$)

TABLE 1. Descriptive statistics and results from ANOVA comparing age and anthropometric characteristics among sport baton twirlers, competitive cheerleaders, and modern dancers. Values represent mean (±*SD*).

	Sport Baton Twirlers (*n* = 18)	**Competitive Cheerleaders (*n* = 20)**	**Modern Dancers (*n* = 18)**	***F*(df1, df2)**	***p***
Age (y)	15.9 (±3.0)	14.6 (±2.2)	15.6 (±2.9)	1.329 (2, 53)	0.273
Weight (lbs)	134.2 (±24.2)	123.3 (±27.6)	115.8 (±18.3)	2.722 (2, 53)	0.075
Height (in)	65.7 (±2.4)	63.0 (±2.2)	63.8 (±3.4)	4.748 (2, 53)	0.013
BMI [(lbs/in^2) · 703]	21.9 (±3.7)	21.7 (±3.9)	20.0 (±2.0)	1.757 (2, 53)	0.182
Body fat (%)	28.7 (±5.8)	27.1 (±5.8)	25.9 (±4.6)	1.161(2, 53)	0.321

Shown in Table 2 are results from ANCOVAs on the flexibility-related measures of physical fitness among the three sport groups. Significant differences were found among the three sport groups for the sit and reach test ($p = 0.022$). Fisher's LSD post hoc

analysis showed that modern dancers had significantly greater hamstring flexibility than sport baton twirlers ($p = 0.007$).

TABLE 2. Descriptive statistics and results from ANCOVA comparing flexibility-related measures of physical fitness among sport baton twirlers, competitive cheerleaders, and modern dancers. Values represent mean (±*SD*).

	Sport Baton Twirlers (*n* = 18)	**Competitive Cheerleaders (*n* = 20)**	**Modern Dancers (*n* = 18)**	***F*(df1, df2)**	***p***
Sit and Reach Test (in)	20.3 (±6.5)	21.2 (±4.3)	23.8 (±1.6)	4.107 (2, 53)	0.022
Trunk Rotation Test Rightward (°)	137.3 (±20.7)	129.3 (±17.8)	121.8 (±21.8)	3.017 (2, 53)	0.058
Trunk Rotation Test Leftward (°)	138.2 (±23.0)	131.9 (±13.4)	126.1 (±23.8)	1.639 (2, 53)	0.204
Shoulder and Wrist Elevation Test (in)	3.2 (±7.2)	-0.1 (±4.3)	-1.6 (±8.0)	2.217 (2, 53)	0.119

Shown in Table 3 are the results from ANCOVAs on non-flexibility related measures of physical fitness among the three athletic groups. Significant differences were found among the three sport groups for the alternate hand wall toss test ($p < 0.001$), push-up fitness test ($p = 0.002$), the Harvard step test fitness index ($p = 0.009$), right handgrip strength ($p < 0.001$), and left handgrip strength ($p = 0.012$). Fisher's LSD post hoc analysis showed that sport baton twirlers completed a significantly higher number of alternate hand wall tosses than competitive cheerleaders and modern dancers ($p < 0.001$ for both), scored higher on the Harvard step test fitness index than competitive cheerleaders ($p = 0.028$) and modern dancers ($p = 0.003$), possessed greater right handgrip strength than both competitive cheerleaders and modern dancers ($p < 0.001$ for both), and possessed greater left handgrip strength than competitive cheerleaders ($p = 0.010$) and modern dancers ($p = 0.07$). The same analysis also showed that modern dancers performed significantly better than competitive cheerleaders in the push-up

fitness test ($p < 0.001$). No significant differences were found in push-up fitness between sport baton twirlers and either of the other two groups.

TABLE 3. Descriptive statistics and results from ANCOVA comparing non-flexibility related measures of physical fitness among sport baton twirlers, competitive cheerleaders, and modern dancers. Values represent mean (±*SD*).*

	Sport Baton Twirlers (*n* = 18)	**Competitive Cheerleaders (*n* = 20)**	**Modern Dancers (*n* = 18)**	***F*(df1, df2)**	***p***
Alternate Hand Wall Toss Test (No.)	30 (±4)	21 (±3)	21 (±5)	21.716 (2, 51)	< 0.001
Vertical Jump Test (in)	9.0 (±3.0)	8.2 (±2.7)	9.4 (±2.4)	0.777 (2, 53)	0.465
Push-up Fitness Test (No.)	26 (±14)	26 (±9)	40 (±22)	7.372 (2, 53)	0.002
Sit-up Fitness Test (No.)	60 (±48)	42 (±22)	61 (±35)	2.524 (2, 53)	0.090
Harvard Step Test Fitness Index (score)	95.2 (±16.1)	87.6 (±7.0)	84.4 (±7.4)	5.192 (2, 53)	0.009
Handgrip Strength Test Right Hand (lbs)	33.5 (±13.9)	19.0 (±4.5)	18.9 (±6.6)	9.906 (2, 53)	< 0.001
Handgrip Strength Test Left Hand (lbs)	28.4 (±14.3)	17.2 (±4.7)	16.5 (±7.1)	4.877 (2, 53)	0.012

*Values reflect raw scores before transformation.

Shown in Table 4 are results from ANCOVAs on self-reported questionnaires for psychological measures among the three sport groups. No significant differences were found among the three sport groups for the EAT-26, BSQ, and Rosenberg self-esteem scale.

TABLE 4. Descriptive statistics and results from ANCOVA comparing self-reported questionnaires for psychological measures among sport baton twirlers, competitive cheerleaders, and modern dancers. Values represent mean (±*SD*).*

	Sport Baton Twirlers (*n* = 18)	**Competitive Cheerleaders (*n* = 20)**	**Modern Dancers (*n* = 18)**	***F*(df1, df2)**	***p***
EAT-26 (score)	6.4 (±3.8)	9.7 (±9.7)	4.7 (±5.5)	1.642 (2, 53)	0.204
Rosenberg self-esteem scale (score)	24.7 (±4.4)	23.0 (±5.8)	26.3 (±5.1)	1.525 (2, 53)	0.227
Body Shape Questionnaire (score)	69.7 (±32.6)	75.8 (±35.3)	58.3 (±24.2)	1.369 (2, 53)	0.693

*Values reflect raw scores before transformation.

CHAPTER 4

DISCUSSION

Sport baton twirlers, competitive cheerleaders, and modern dancers are three competitive activities that require similar anthropometric characteristics, physical fitness skills, and psychological adaptations. However, a paucity of research has been conducted on sport baton twirlers. In the present study, sport baton twirlers were similar to competitive cheerleaders and modern dancers in BMI and body fat. Despite the discrepancy in BMI and percent body fat levels, modern dancers possessed BMI levels between the 25th and 50th percentile (Kuczmarski et al., 2001) and percent body fat at the 50th percentile (Laurson et al., 2011) according to normative data. Competitive cheerleaders looked similar possessing both BMI and percent body fat levels between the 50th and 75th percentile (Kuczmarski et al., 2001, Laurson et al., 2011). For sport baton twirlers, they also possessed both BMI and percent body fat levels between the 50th and 75th percentile (Kuczmarski et al., 2001, Laurson et al., 2011). Although there was a trend for sport baton twirlers to be heavier, this may be related to the fact that they were 1.9 inches taller than modern dancers and 2.7 inches taller than competitive cheerleaders. Although sport baton twirling is considered an aesthetic sport, weight and height may not have the same impact on competitive success in this sport as it does in similar sports. In competitive cheerleading, stunts in which the individual (flyer) is lifted and tossed into the air is a major component of the structure of competitive cheerleading routines. Therefore, the flyer being shorter and lighter will provide a distinct advantage in performing a variety of aerial stunts. Partner lifts can also be incorporated into modern

dance programs and again, success of these lifts may be dependent on a shorter, lighter person being lifted.

Sport baton twirlers require greater trunk, wrist, and shoulder flexibility due to the use of the upper body strength needed in completing baton twirling maneuvers. Unexpected was the fact that no significant differences in rightward and leftward trunk rotation or shoulder and wrist elevation were found among the three groups. Upon further analysis, a histogram on trunk rotation revealed two separate distributions for rightward trunk rotation within the baton twirling group. A t-test showed significantly greaterrightward trunk rotation in one portion of the group over the other ($t = 11.221$; $p < 0.001$), indicating one group may have been more advanced than the other or that a portion of the sport baton twirlers were more dominant on their right side.

Modern dancers displayed significantly better hamstring flexibility than sport baton twirlers. Routine content for modern dancers include kicks or battements, leaps, and body movements, such as illusions, that require extensive hamstring flexibility. However, scores were above average for all three sports groups with modern dancers scoring above the 80th percentile and sport baton twirlers and competitive cheerleaders scoring above the 60th and 70th percentile respectively, for hamstring flexibility (YMCA, 2000).

Sport baton twirlers, competitive cheerleaders, and modern dancers had similar lower body power and abdominal muscular endurance. Athletes from all three groups are required to perform a variety of leaps and jumps that rely upon lower body power and abdominal strength. Modern dancers displayed significantly better upper body endurance than competitive cheerleaders, which may be related to a greater reliance upon upper

body strength for handstands, controlled falls, and partnering maneuvers required of their routines. This may explain the superior upper body endurance found in this group of athletes.

The alternate hand wall toss test is reported to be a reliable measure of hand-eye coordination which is an important skill for throwing and catching the baton. Sport baton twirlers scored significantly better on the alternate hand wall toss test and handgrip strength test in both hands compared to competitive cheerleaders and modern dancers. These findings are not surprising since sport baton twirlers are required to throw the baton greater than 40 feet into the air and while following it with their eyes, perform spins or dance/gymnastics movements while catching it in one hand or flowing directly into the following toss or twirl. Dropping the baton results in a penalty deducted from the final score. Therefore athletes with better hand-eye coordination will be more successful in the competition setting. Baton twirlers must also use both hands to throw the baton high enough into the air with a fast enough speed of revolutions to allow time for performance of all choreographed movements before catching the baton. Therefore this task requires a great deal of hand and forearm strength. Competitive cheerleaders and modern dancers do not use an apparatus of any sort that requires throwing and catching maneuvers, therefore hand-eye coordination and hand and forearm strength may not be as important a skill for their performance.

Most interesting was the fact that sport baton twirlers had significantly higher aerobic fitness levels than competitive cheerleaders and modern dancers. Previous research had shown that competitive cheerleaders possess similar aerobic fitness levels to other athletes, i.e. basketball players, swimmers, tennis players, gymnasts, and volleyball

players (Thomas et al., 2004) and modern dancers have significantly higher aerobic fitness levels than untrained females of the same age. However, their values were lower than that of elite female endurance and aerobically trained athletes (Padfield et al., 1993, Baldari et al., 2001, Koutedakis et al., 2007). Sport baton twirlers perform two to three minute routines that require speed of both body and baton without stopping, while modern dance routines may be choreographed to slower pieces of music with the possibility of more pauses choreographed into the program. Competitive cheerleading routines also choreograph pauses into their routines to allow time to set up for stunting and to allow time for specialty gymnastic maneuvers to occur. Growing evidence has emerged to show that high intensity interval training that includes brief bursts of 20-30 seconds of intense exercise followed by 10 seconds of rest, elicits similar, and in some cases, superior improvements in aerobic capacity compared to traditional endurance-based training (Gibala et al., 2012). A higher intensity of training may be one possibility why sport baton twirlers have significantly higher aerobic fitness levels than modern dancers and competitive cheerleaders despite the fact that their performance times are of much shorter duration. Future research should include an examination of VO_2 levels throughout individual and group routines to determine specific energy requirements of each sport to better understand the different intensities of training necessary for performance.

All three groups had similar scores in the EAT-26 and BSQ, with competitive cheerleaders having the highest proportion of athletes (15.0 %) with lower self-esteem as determined by the Rosenberg self-esteem scale, followed by modern dancers (5.6 %) and sport baton twirlers (0.0 %), respectively. Previous research has shown that collegiate

auxiliary members, including majorettes, dancers, and cheerleaders possess increased risk of developing disordered eating, which may be attributed to style of the uniform (Torres-McGehee et al., 2009). In the present study, 12.6% of our athletes showed moderate to marked concern over body shape, while 5.6% of modern dancers elicited a severe risk of disordered eating, followed by competitive cheerleaders (5.0%) and sport baton twirlers (0.0%), respectively. Thus, our study corroborates previous findings indicating greater risk for disordered eating and body image concerns among competitive cheerleaders and dancers (Davison et al., 2002, Torres-McGehee et al., 2009, Thompson and Digsby, 2004). However, our data does not support previous research showing greater self-esteem in these athletes since 15.0% of competitive cheerleaders and 5.6% of modern dancers showed values consistent with low self-esteem.

There were several limitations to consider when evaluating the results of this study. Since a specific population of competitive athletes was used, this resulted in a small sample size which limited the power of the analysis. This was particularly evident when evaluating scores on the self- reported questionnaires. Although each group of athletes was required to have state, regional, or national competition experience in their respective sport, it is unknown what their competitive level or exact placement was in those competitions. It is also unknown whether they competed as an individual or team member, or in both competitions. Furthermore, years of experience in training were not reported during the study. Younger female athletes may have spent considerably less time training than older female athletes and this may have influenced the variability observed in certain measures. Anthropometric measurements, physical fitness skills, and self-reported questionnaires were based upon previous literature examining competitive

cheerleaders and modern dancers, therefore it is unknown if there are other measures better suited to evaluate the skills required of sport baton twirling. Due to the small selection of previous studies on aesthetic sports, investigators relied upon a smaller pool of physical fitness tests. Reliability and validity data was not found for the shoulder and wrist elevation test and the alternate hand wall toss test, however, these tests were used in previous research studies examining similar characteristics (Gavkare et al., 2011; Mirzaei et al., 2011; Toit et al., 2010).

Baton twirling has strived to be recognized as a competitive sport that requires high levels of flexibility, coordination, power, muscular strength and endurance, and cardiorespiratory fitness similar to its competitive counterparts, i.e. competitive cheerleading and modern dancing. Our research confirms previous findings in that there were no differences in psychological characteristics among the three sport groups. It also supports the fact that there are distinct differences with respect to anthropometric characteristics and measures of physical fitness among the three groups that may be related to performance or that differences observed among the groups may be related to their different type of training. Further research is necessary to examine what anthropometric and physical fitness tests may be better suited to reflect requirements specific to each of the three sport groups.

Practical Applications

The purpose of this study was to examine age and anthropometric characteristics, physical fitness measures, and self-reported behavioral and psychological questionnaires among three groups of competitive athletes. Given the fact that sport baton twirlers had higher aerobic fitness levels, hand and forearm strength, and superior hand-eye

coordination, this may help coaches and athletes to incorporate high intensity interval training, hand-eye coordination drills, and hand, wrist, and forearm strength training into their conditioning program to further improve performance. Furthermore, it would be important for modern dancers to focus upon upper body endurance and hamstring flexibility training to better improve their sport performance. Finally, more research should be performed on competitive cheerleaders to determine other areas of skill development that may be specific to their sport performance. Since all three sports have been underrepresented in the literature, it is incumbent upon researchers to examine a greater variety of physical skills fundamental to performance in aesthetic sports.

REFERENCES

1. American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription* (8th ed.). Philadelphia, PA: Lippincott, Williams, & Wilkins, 2010.

2. Baldari C, Guidetti L. $VO_{2\ max}$, ventilator, and anaerobic thresholds in rhythmic gymnasts and young female dancers. *J Sports Med Phys Fitness* 2001; 41: 177-182.

3. Brouha L, Health CW, Gaybriel A. Step test simple method of measuring physical for hard muscular work in adult men. *Rev Canadian Biol* 1943; 2: 86.

4. Cooper PJ, Taylor MJ, Cooper Z, Fairburn CG. The development and validation of the body shape questionnaire. *Int J Eat Disorder* 1986; 6: 485-494.

5. Davison KK, Earnest MB, Binch LL. Participation in aesthetic sports and girls' weight concerns at ages 5 and 7 years. *Int J Eat Disord* 2002; 31: 312-317.

6. Doninger GL, Enders CK, Burnett KF. Validity evidence for eating attitudes test scores in a sample of female college athletes. *Meas Phys Educ Exerc Sci* 2005; 9: 35-49.

7. Espina A, Asuncio Ortego M, Ochoade Alda I, Aleman A, Juaniz M. Body Shape and eating disorders in a sample of students in the Basque country: a pilot study. *Psy Spain* 2002; 6: 3-11.

8. Evans K, Refshauge KM, Adams, R. Measurement of active rotation in standing: reliability of a simple test protocol. *Percept Motor Skill* 2006; 103: 619-628.

9. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The eating attitudes test: psychometric features and clinical correlates. *Psy Med* 1982; 12: 871-878.

10. Gavkare AM, Nanaware NL, Waghmare AR, Taware GB, Surdi AD. Study of flexibility, agility, and reaction time in circus artists. *Int J Recent Trends Sci Tech* 2011; 1: 49-55.

11. Gibala MJ, Little JP, MacDonald MJ, Hawley JA. Physiological adaptations to low-volume, high-intensity interval training in health and disease. *J Physiol* 2012; 590: 1077-1084.

12. Golding, LA. YMCA Fitness Testing and Assessment Manual (4th ed.). Champaign, IL: Human Kinetics for YMCA of the USA, 2000.

13. Goodwin EP, Adams KJ, Shelburne J, DeBeliso M. A strength and conditioning model for a female collegiate cheerleader. *Strength Cond J* 2004; 26: 16-21.

14. Hein V, Hagger MS. Global self-esteem, goal achievement orientations, and self-determined behavioral regulations in a physical education setting. *J Sports Sci* 2007; 25: 149-159.

15. Johnson BL, Nelson JK. *Practical Measurements for Evaluation in Physical Education* (4th edition), New York, New York: MacMillan, 1986.

16. Koutedakis Y, Hukam H, Metsios G, Nevill A, Giakis 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: 808-12.

17. Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, Wei R, Curtin LR, Roche AF, Johnson CL. 2000 CDC growth charts for the United States: methods and development. National Center for Health Statistics. *Vital Health Stat* 2002; 11: 1-203.

18. Laurson, KR, Eisenmann JC, Welkk GJ. Body fat percentile curves for US children and adolescents. *Am J Prev Med* 2011; 41: S87-S92.

19. McConnell KE, Swan PD. Body esteem and body shape satisfaction in women with regional adiposity. *J Soc Behav Pers* 2000; 15: 505-513.

20. Mirzaei B, Curby DG, Barbas I, Lofti N. Anthropometric and physical fitness traits of four-time world Greco-Roman wrestling champions in relation to national norms: a case study. *J Hum Sport Exerc* 2011; 6:406-413.

21. Padfield JA, Eisenman PA, Luetkemeier MJ, Fitt SS. Physiological profiles of performing and recreational early adolescent female dancers. *Pediatr Exerc Sci* 1993; 5: 51-59.

22. Rosenberg, M. *Society and the Adolescent Self-Image* (Revised edition). Middletown, CT: Wesleyan University Press, 1989.

23. Sargent DA. The physical test of a man. *Am Phys Educ Review* 1921; 26: 188-192.

24. SooHoo S, Sell K, Reel JJ. Cheerleading. *Berkshire Encyclopedia of World Sport* 2005; 1: 301-6.

25. Thomas DQ, Seegmiller JG, Cook TL, Young BA. Physiologic profile of the fitness status of collegiate cheerleaders. *J Strength Cond Res* 2004; 18: 252-54.

26. Thompson SH, Digsby S. A preliminary survey of dieting, body dissatisfaction, and eating problems among high school cheerleaders. *J School Health* 2004; 74: 85-90.

27. Toit PJ, Kruger PE, Fowler KF, Govender C, Clark J. Influence of sports vision techniques on adult male rugby players. *Afr J Phys Health Educ Recr Dance* 2010; 16: 510-517.

28. Top End Sports. http://www.topendsports.com/testing/tests/wall-catch.htm.

29. Torres-McGehee TM, Green JM, Leeper JD, Leaver-Dunn D, Richardson M, Bishop PA. Body image, anthropometric measures, and eating-disorder prevalence in auxiliary unit members. *J Athl Training* 2009; 44: 418-26.

30. World Baton Twirling Federation. www.wbtf.org/about/sport.