The Effects of Ultra-short Game-pace Training on Selected Physical Conditioning Components in Female Basketball Players: A Pilot Study

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Abstract

Ultra-short race-pace training is a recent and controversial model developed initially for swimming. It has been proposed as being appropriate for conditioning in any sport that requires aerobic and anaerobic fitness. This study applied the model to be performed in the specific-conditioning activities of basketball. Two matched-groups of female basketball players, one following a traditional-training protocol and the other following an ultra-short game-pace protocol (USGPT), were compared for changes in shuttle-running (*Test 17*), vertical jump, reaction-time and acceleration tests, speed and agility, and the Yo-Yo intermittent recovery test. The traditional training group performed exercises designed to develop each aspect of physical conditioning separately. To preserve training specificity, the USGPT group practiced four activities: box agility, defense slide drill, beat the clock, and the 2-cone weave drill. Conditioning was conducted three times per week for 12 weeks with each training session lasting approximately 40 minutes. Traditional training produced significant improvements in the vertical jump and acceleration over 10 m. USGPT significantly changed the six target measures. When post-treatment measures were compared, only the *Tes -17* and speed and agility tests were significantly better in the USGPT group although all test scores were better in that group. The four training activities used by the USGPT group improved significantly over the duration of the study. USGPT was shown to be more effective than traditional conditioning for changing performance and physical tests associated with basketball. Being a pilot study, replication and further studies were recommended to assess the efficacy of ultra-short game-pace training in basketball players of both genders and in other sports.

Introduction

Basketball is one of the most popular games in the world. It is a sport that has many locomotor pattern changes throughout a game which usually lasts 40 minutes. The special physical preparation activities in basketball should contain sprinting for varied but short distances to stimulate the development of speed, endurance, and agility. At practices, players should make repeated performances and overcome inertia with the repetition of short intense bursts of an exercise at close to maximum velocity. Abdelkrim, Fazaa, and Atil (2007) conducted time-motion analyses of basketball games and found that players performed repeated high-velocity sprints during games. It was inferred that to succeed in basketball games, the principal energy system employed was anaerobic metabolism.

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In 2000, the International Basketball Federation issued rule-amendments stipulating that an offensive team's time to travel to the front court be reduced from 10 to 8 seconds. The duration of each offense by a team was reduced from 30 to 24 seconds (Cormery, Marciland, & Bouvard, 2008). Those rule changes led to increases in tactical and physical-intensity requirements, resulting in the game being faster and influenced more by players' physiological capacities for anaerobiosis (Abdelkrim, Fazaa, & Atil).

Sprinting is an important factor in basketball and relies primarily on the ATP-CP energy capacity for that activity (Spencer *et al.*, 2005). However, both aerobic and anaerobic energy systems are used during a game (McInnes *et al.*, 1995). Players run approximately 4,500-5,000 meters throughout a full game and employ many movement changes in different directions, intensities, and skills (e.g., running and dribbling as well as changing pace and jumping; Crisafulli *et al.*, 2002). That led to the belief that anaerobic metabolism is the most important physiological requirement for playing basketball. Hence, training should focus on anaerobic physical conditioning (Hunter, Hilyer, & Forster, 1993; McInnes *et al.*; Tavino, Bowers, & Archer, 1995; Crisafulli *et al.*, 2002; and Taylor, 2004). For anaerobic responses to be stimulated, the aerobic system has to be maximally functional. Hence, anaerobic training will also provoke aerobic adaptation.

Abdelkrim *et al.* (2010) found that the shortening of the game phases also increased the contribution of plasma lactate indicators, which signal the high contribution of the anaerobic energy capacity, especially at the end of the game's quarter-time periods. Playing positions varied in the burden placed on the cardiovascular system with playmakers and guards being more than centers. It was also observed that there was a decline in the level of physical performance in the second and fourth quarters in all players no matter what their playing position (Abdelkrim *et al.*).

Specificity of Training

The *Principle of Specificity* is one of the most important physiological structures underlying the physiology of training. Physical conditioning should be appropriate for and correspond to the nature of activity intensities in the competitive settings of a sport. The specificity principle and the recent rule-changes suggest that physical conditioning should move away from high general-training to high specific-training of mostly an anaerobic nature[2]. When physical training replicates the skills and demands of a sport, the performance of the targeted skills and intensities improve and become more effective (Quinn, 2014). When specific training is employed, the training overload falls on the body and its different energy capacities leading to a type of physiological adaptation that is quite specific to the physical activities employed at practices (Schmidtbleicher, 1992; Zatsiorsky, 1995). Motor-learning theories indicate that the use of continuous specific-skills performance-related exercises is better than using a variety of random general exercises (Schmidt & Bjork, 1992). The specificity principle in training is a significant key to the success of athletes' physical-conditioning programs.

From a physiological perspective, speed refers to the ability of the body to perform muscular work at maximum velocity (Steinhöfer, 2008). It is generally acknowledged that using

[2] Although anaerobic adaptations are the goals of training, aerobic-capacity stimulation will also be maximal. The degree to which both capacities are altered depends upon the volume of relevant specific-training undertaken.

different exercises to develop speed and agility separately contravenes the nature of actual performance during a basketball game where speed and agility mix together. When simple speed exercises are performed alone, their influence is an improvement in speed in a linear manner while they have little effect on agility, and vice versa. The exercise performance improves but there is little change in more complicated multi-facet activities. Simple-exercise training for one performance feature does not replicate the nature of performance in basketball games (Young, McDowell, & Scarlett, 2001). In order for a player to experience the specificity principle during physical conditioning, exercises that resemble the nature of basketball-game activities should be performed. Sprinting over short and different distances and directions mirrors the locomotor aspects of basketball games. When those sprints also involve basketballs, such as dribbling, passing between two players, etc., the specificity of training is increased further. Sprinting involved with distinct directional changes also increases the agility value of a basketball-training exercise.

Ultra-short Training

If the nature of basketball practice activities is increased in specificity, particularly an increase in exercise intensity (movement velocity), the task of programming greater volumes of higher-intensity work becomes challenging for basketball coaches. In the late 1950s-early 1960s, Swedish researchers (e.g., Astrand *et al.*, 1960; Christensen, Hedman, & Saltin, 1960; Christensen, 1962) showed that when the intensity of exercise is high (i.e., at least above VO_{2max} for the exercise activity), short-work and short-rest interval training fosters greater volumes of high-intensity training than longer work and rest intervals at the same work intensity. Exactly what is "short" has been loosely indicated by Margaria, Edwards, and Dill (1933). They showed that no extra lactic acid appears in the blood after exercise involving an oxygen debt in the range of 1.5 to 2.5 liters. When exercise requires a larger amount of oxygen, lactic acid accumulates at the rate of 7 g for each liter of additional oxygen debt. Thus, the short-work interval should be sufficient to stimulate increasing amounts of stored oxygen (e.g., myohemoglobin), converting Type IIb (fast-twitch glycolytic) to Type IIa (fast-twitch aerobic) fibers, and improving the transport and use of inspired oxygen. Those multiple effects are not present in work loads below VO_{2max} for the activity (Rushall, 2011). Short-work, short-rest, high-intensity interval-training has been labeled *ultra-short interval-training* (Rushall, 2011; Rushall & Pyke, 1991).

The adaptation of short-work short-rest high-intensity interval-training has been fully expounded for the sport of swimming (Rushall, 2011, 2017). It is recognized that the training paradigm is appropriate for any sport that requires technique and/or fitness developments. In swimming, it is known as *ultra-short race-pace training* (USRPT). Since it is a basic principle of biomechanics that the techniques of activities change with changes in performance velocities/intensities and/or fatigue, for swimming, the most appropriate training for races is to maintain a particular race-pace for as long as possible in a training set of repetitions (the *training stimulus*). The declaration of a set number of interval repetitions (e.g., 25 x 50 m at 200 m Freestyle race-pace) is not a guarantee that the training stimulus will produce a further training adaptation that will be reflected in training and hopefully competition performances. To solve that problem, swimmers perform as many short-work short-rest race-pace specific repetitions until the performance can no longer be maintained. By stopping USRPT when performance failure(s) occurs (the stage of neural fatigue), the athlete will experience an optimal training stimulus rather than one that is too easy (submaximal work load) or too hard (excessive general physical fatigue). Varied training responses in a defined set of interval repetitions will result from all team/squad members doing the same number of repetitions (Howat & Robson, 1992). To experience the best conditioning training for any sport, work outputs have to be sustained until no matter how hard an athlete tries, the performance standard of the exercise set cannot be resurrected without full recovery and overcompensation. Within a sporting group, conditioning activities have to be performed to every athlete's stage of neural fatigue resulting in different between-individuals training volumes depending upon the physical capacities, stage of training, general fatigue state, etc. of the individual athletes.

In USRPT, proceeding with an exercise-repetition set is terminated if an athlete cannot sustain the specified duration or intensity of an exercise. Ceasing to train at that stage of fatigue has hypothetical benefits of making the nervous system retain all the physiological and technical requirements for performing at the targeted exercise intensity and avoids detrimental excessive fatigue. In swimming, it influences the performance of an actual race as the nervous system is less likely to direct the body to perform at speeds that have not been practiced sufficiently during actual training (Rushall, 2011). There are two purposes for discontinuing the performance of the training set when the athlete can no longer perform at a targeted standard. First, the athlete identifies and reappraises the requirements of the targeted training-velocity to perform in the latter repetitions within the training set. The one performance standard for every repetition in an interval-training set focuses the attention and efforts of the athlete on a restricted set of performance characteristics. Performing the latter repetitions in a set at different speeds/intensities would expose the athlete to different physiological requirements resulting in different training effects some or most of which would be irrelevant for competitions in the sport. Much more general fatigue rather than specific fatigue would be experienced. Second, proceeding with the training set repetitions is the correct method to reach the right physical overload limit without it becoming excessive (Rushall, 2011).

The USRPT method employs several basic physiological principles. Most importantly, working for short intervals with high physical overloads/intensities/velocities requires maximum oxygen uptake, which becomes insufficient if the working intervals become too long. The short-work interval can develop a small amount of oxygen debt which has to be repaid very close to entirely during the short-rest period. Despite an amount of work without oxygen, the accumulation of lactate does not occur in an influential manner because the small amount of lactate is resynthesized during the discrete short-rest intervals. As well, short-work short-rest high-intensity training does not place a great strain on glycogen stores. With longer work and longer rest intervals, blood acidosis increases and glycogen stores are depleted. Short-work high-intensity training items, increase the amount of oxygen that is stored and transported as well as converts fast-twitch fibers to the desirable aerobic form. USRPT increases the amount of oxygen that can be used in a specific intensity-level of exercise much more so than occurs with traditional and longer training-item programs. This is one of the most important values of using this USRPT method compared to traditional methods (Rushall, 2013).

In traditional basketball training, speed and agility are often approached by requiring single-capacity limited exercises. The effectiveness of specific exercises that combine speed and agility has been studied (Hewett *et al.*, 2005; Padua & Marshall, 2006; Meyer, Ford, &

Palumbo, 2005). It was found that performances improved and injuries, especially lower-limb injuries, were reduced.

Ultra-short sport-specific training should be an improvement over traditional training methods, mostly because it demands that the skills and physical nature of basketball games are replicated at practice. Incorporating ultra-short training with exercise intensities that match the requirements of serious basketball games seems like a reasonable strategy for improving the basketball practice experience for players as well as better-preparing players to execute game-appropriate activities with an improved physically conditioned state. The practice experience should also improve if exhaustive activities are replaced by demanding activities that produce performance changes while keeping lactate values and the state of glycogen stores at levels that support adaptive responses.

To adapt USRPT to basketball, activities should be practiced at game-pace (i.e., game intensities of effort). Thus, USRPT is better served for basketball by being named *Ultra-short Game-pace Training* (*USGPT*). The duration of USGPT repetitions most likely will be very short because during very high-intensity exercises, breath-holding is likely to be demonstrated for most of each repetition. One effect of no breathing is that oxygen debt increases very quickly. Consequently, the duration of high-intensity specific-basketball activities should be very short. A convenient and mostly appropriate repetition distance is across the court. That usually allows players to have sufficient personal space to stop, change direction, and execute skills (e.g., dribbling during the repetition) without interfering with another player at the practice.

The USGPT method remains a theoretical structure until it is empirically verified. This study aimed to compare the training effects on selected basketball-related physiological and performance factors of the USGPT method and a traditional training method in serious female basketball players. It is likely that USGPT would have superior training effects (Rushall, 2014). Such a study would be the first evaluation of USGPT and its comparison with an established basketball training method.

Method

Participants

The first degree female basketball teams from the Shooting Sports Club and Al-Ghaba Sports Clubs served as subjects. One club was randomly assigned to the USGPT experimental treatment (N = 10) and the other club participated in a traditional training/control treatment group of 10 members.

Experimental Design

The experimental design used in this study was a Pretest-posttest Two-group Design which employed a different treatment, USGPT training or traditional training, for each equal-sized (N = 10) group.

Dependent Variable Assessments

Both treatment groups underwent the same testing procedures over two days prior to and after the treatments.

Day 1

- Body weight and height.
- After a general warm-up followed by a 10-minute recovery period, a single test was performed.

  Test 17: A shuttle-run across the court requiring the first line to be touched with the hand and the second line on the return width to be touched with the ankle of the opposite foot was performed 17 times (Castagna *et al.*, 2008). Two trials were performed with a 5-minute rest-interval between trials. The best time was used as a datum.

Day 2

- *Vertical jump*: This test of leg muscular ability involved a vertical jump with both arms swung to reach the highest point possible was performed three times. The best jump-height served as a datum.
- *Reaction-time and acceleration test*: Subjects sprinted a short distance (~20 meters) to determine reaction-times and acceleration at the 5- and 10-meter marks (Boon & Bourgois, 2013). The test was repeated twice with a 3-minute rest interval between trials. The best of the two trials served as a datum.
- *Speed and agility test*: Five 10-m runs were performed at maximum speed. The arrival time at the 10-m sign was the speed test and the time for turning around was considered the agility test. The best times served as data.
- *The Yo-Yo intermittent recovery test*: A subject ran between two lines 20 meters apart. Another line was 2.5 m behind the start line defining an area where the player stands for recovery after each cross-and-back run. The running and recovery was performed every 15 seconds. Each run was signaled to start by a "beep" at 15-second intervals. The test was stopped if the subject exceeded 15 seconds for the complete trial (Castagna *et al.*, 2008). The total distance covered until termination served as a datum.

Treatments (Independent Variables)

The two groups were treated differently. The components of the physical training practice section differed. The USGPT format was used for the USGPT group. Traditional training was designed for the traditional-training group by selecting sets of exercises that aimed at developing each aspect of physical conditioning separately.

Features of USGPT were as follows.

- So that USGPT can proceed correctly, it was necessary to measure the duration of each training item. The time for each one of four exercises at the beginning of the USGPT program was treated as a simulation test for the players' movements during a game. They were measured for the USGPT group but not the traditional/control group so they could be compared after the implementation of the USGPT program (see Table 1). Task-trials were repeated with the player attempting to beat or equal the target time on as many trials as possible. Repetitions ceased when on two consecutive trials, the target time was not achieved.

TABLE 1. THE FOUR EXERCISES USED SPECIFICALLY WITH THE USGPT GROUP.

Exercise 1: Box Agility Distance of each of five legs in the exercise 18.28 m. Total distance of the complete exercise 18.28 m x 5 = 91.44 m. Average exercise performance time 45.0 seconds.
Exercise 2: Defense Slide Drill Distance of each of 18 legs in the exercise 4.57 m. Total distance of the complete exercise 4.57 m x 18 = 82.26 m. Average exercise performance time 40 seconds.
Exercise 3: *Beat the Clock* Distance of each of 12 legs in the exercise 2.30 m. Four repetitions of the 12-leg exercise. Total distance of the complete exercise 2.30 m x 12 x 4 = 110.40 m. Average exercise performance time 55 seconds.
Exercise 4: 2-cone Weave Drill Distance of each of 4 legs in the exercise 6.00 m. Four repetitions of the 4-leg exercise. Total distance of the complete exercise 6.00 m x 4 x 4 = 96.00 m. Average exercise performance time 40 seconds.

- The four USGPT exercises were repeated 10 times (or less if target performance could not be maintained), with 20 seconds rest between repetitions. Two minutes rest was scheduled after each block of three repetitions.
- The two programs were conducted three times per week for 12 weeks at 5:00 PM on all occasions. The duration of each treatment in each training session was approximately 40 minutes. The maximum number of exposures to an experimental variable was 36.
- The structures of practice sessions were similar.
    - Warm-up for 10 minutes with general exercises and dynamic stretching.
    - Application of specific treatments – USGPT exercises for the USGPT group and separate physical fitness capacity exercises (speed, agility, endurance) for the traditional-training group.
    - Technical training – skills.
    - Tactical training – game tactics.

Traditional-program design attempted to produce common exercise formats that were used in supplementary training experiences in traditional basketball programs. The development of speed, agility, and endurance was approached by using a single exercise to stimulate only one of the physical capacities at a time. The selected exercises had to be executed during the time allocated in the experiment. The implementation of these exercises was according to common practices without determining sprinting distances, directions, times, or personal targets for every player.

USGPT program design included activities that were developed to adhere to the general structure of USRPT exercises: short performance time, short rest, and simulation of actual playing conditions and performance levels of a game. Exercises were repeated at practice until the performance of two consecutive trials failed to reach the determined standard (see Table 1 for the duration of a single trial for each of the four exercises). A player's improvement was measured in terms of the increased number of successful repetitions in each training phase. If a player achieved 10 successful repetitions in an exercise in the experimental stage of the study, the remaining practice-session targets were attempted to be maintained at 10.[3]

Statistical Analysis

Since two existing matched groups were assigned a different treatment, the assumption that the data used in parametrical statistical analyses were representative of a normal distribution needed to be tested. The pre-test scores of the measures used in the study were pooled and skewness evaluated.

A variety of two-group comparisons were made using the student's *t*-test. The comparisons were: i) USGPT group versus Traditional-training group's pre-treatment scores; ii) Traditional-training group's pre- versus post-treatment scores; iii) USGPT group's pre- versus post-treatment scores; and iv) USGPT group versus Traditional-training group's post-treatment scores. A final analysis of the performance changes in the USGPT group's performances on the four USGPT exercises was performed.

Because so many *t* tests were performed to compare subsets of data, the prospect of an increased likelihood of type I errors being made was increased. Consequently, the alpha level for significance was raised from the traditional/common .05 level to a more stringent .01 level to partly offset the likelihood of a misleading significant statistic.

The alpha value of .01 was considered to best be interpreted as a two-tail test of significance. While it is reasonable to assume that training would improve all test performances, in hind-sight that was shown not to be the case. The speed and agility test for the traditional-training group was actually worse at the end of the experimental period whereas all other tests changed positively in varied amounts (see Table 4).

Results

In order to enhance confidence that the subjects' pre-treatment test results represented a similar normal distribution, all pre-treatment data of the two intact groups were combined. Table 2 shows that all measures were dispersed within an acceptable normal distribution enhancing one's confidence that the characteristics of the pre-treatment groups were similar.

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[3] On some occasions, when a set of 10 successful trials was a practice session's exercise target, a player might fail to perform the target amount. Reasons for such failures were not sought but did illustrate that players attended practice varying from day-to-day in their potential to perform maximally.

TABLE 2. TESTS OF THE NORMALITY OF POOLED PRE-TREATMENT GROUP-DATA.

Tests	Unit of measure	Mean	Standard deviation	Skewness*
Height	Meter	1.72	0.07	-0.18
Weight	Kg	70.28	11.83	0.83
BMI	Point	23.60	2.96	-0.47
Test 17	Second	72.85	2.79	-0.08
Vertical jump	Cm	34.60	5.52	1.75
Reaction speed and acceleration (5-m sprint)	Second	1.46	0.16	1.05
Reaction speed and acceleration (10-m sprint)	Second	2.39	0.17	-0.25
Speed and agility test	Second	15.55	0.63	0.37
Yo-Yo test	Meter	280	67.43	0.37

*All skewness coefficients fell within the range of ±3 indicating acceptable normality.

Table 3 shows that all *t*-values for pre-treatment test measure comparisons between the two groups were not significant. At the time of the commencement of treatments, the two groups were equivalent on the eight measures considered. While one cannot completely discount the possible influences of intact groups on conclusions drawn from group comparisons, the anthropometrical and performance similarities of both groups further strengthens any conclusions made from statistically significant results.

TABLE 3. A COMPARISON OF PRE-TREATMENT SCORES OF BOTH GROUPS.

Tests	Unit of Measure	USGPT group		Traditional group		*t* value*
		M	SD	M	SD	
Height	Meter	1.74	0.05	1.70	0.09	1.12
Weight	Kg	72.06	12.90	68.50	11.06	0.66
BMI	Point	23.71	3.40	23.48	2.63	0.17
Test 17	Second	72.80	3.01	72.90	2.72	0.08
Vertical jump	Cm	34.90	7.31	34.30	3.27	0.24
Reaction speed and acceleration (5-m sprint)	Second	1.49	0.21	1.42	0.09	1.02
Reaction speed and acceleration (10-m sprint)	Second	2.42	0.21	2.35	0.10	0.84
Speed and agility test	Second	15.31	0.67	15.80	0.50	1.82
Yo-Yo test	Meter	288.00	79.55	272.00	55.94	0.52

*t-value at .01 level of significance (18 df) for a two-tail test needed to exceed 2.878 for significance.

The comparisons of the traditional-training group's pre- and post-treatment test results on six test-variables were made using multiple *t*-tests. Table 4 indicates that test-values changed for the better as a result of the traditional-training treatment in: i) vertical jump (leg muscular ability); and ii) the reaction speed and acceleration (10-m sprint time) test. The changes in the four other tests were within the realm of chance occurrences.

TABLE 4. SIGNIFICANCE OF DIFFERENCES BETWEEN THE PRE- AND POST-TREATMENT MEASURES FOR THE TRADITIONAL-TRAINING GROUP.

Tests	Unit of measure	Pre-treatment measure		Post-treatment measure		Mean difference (post-pre)	*t*-value*
		M	SD	M	SD		
Test 17	Second	72.90	2.73	70.85	2.34	-2.05	2.53
Vertical jump	Cm	34.30	3.27	36.10	3.07	1.80	**9.00***
Reaction speed and acceleration (5-m sprint)	Second	1.42	0.09	1.41	0.08	-0.01	1.87
Reaction speed and acceleration (10-m sprint)	Second	2.35	0.10	2.32	0.09	-0.03	**6.45***
Speed and agility test	Second	15.79	0.50	15.82	0.51	0.03	0.47
Yo-Yo test	Meter	272	55.93	296.5	50.00	24.50	3.10

*t-value at .01 level of significance (9 df) for a two-tail test needed to exceed 3.250 for significance.

Comparisons of the USGPT group's pre- and post-treatment test results on six test-variables were made using multiple *t*-tests. Table 5 indicates that test-values changed for the better as a result of the USGPT-training treatment in all six tests.

TABLE 5. SIGNIFICANCE OF DIFFERENCES BETWEEN THE PRE- AND POST-TREATMENT MEASURES FOR THE USGPT GROUP.

Tests	Unit of measure	Pre-treatment measure		Post-treatment measure		Mean difference (post-pre)	*t*-value*
		M	SD	M	SD		
Test 17	Second	72.80	3.01	64.90	3.38	-7.90	**7.50***
Vertical jump	Cm	34.90	7.31	38.20	7.76	3.30	**9.85***
Reaction speed and acceleration (5-m sprint)	Second	1.49	0.21	1.38	0.21	-0.11	**7.90***
Reaction speed and acceleration (10-m sprint)	Second	2.42	0.21	2.19	0.15	-0.23	**4.05***
Speed and agility test	Second	15.30	0.69	14.09	0.51	-1.22	**8.51***
Yo-Yo test	Meter	288.0	79.55	364.0	72.90	76.0	**13.07***

*t-value at .01 level of significance (9 df) for a two-tail test needed to exceed 3.250 for significance.

Table 6 indicates that two of six tests, *Test 17* and the speed and agility test, were significantly better for the USGPT group than the traditional-training group upon completion of the treatments. USGPT training yielded the biggest effects (time measures were shorter, and distances greater) in all post-treatment assessments. Four tests (vertical jump, reaction speed and acceleration over 5 and 10 meters, and the Yo-Yo test) did not differentiate the two training protocols.

TABLE 6. DIFFERENCES IN POST-TREATMENT MEASURES BETWEEN THE USGPT AND TRADITIONAL-TRAINING GROUPS.

Tests	Unit of measure	USGPT group		TT group		Difference (USGPT-TT)	*t* value*
		M	SD	M	SD		
Test 17	Second	64.90	3.38	70.85	2.34	-5.95	**4.57***
Vertical jump	Cm	38.20	7.76	36.10	3.07	2.1	0.8
Reaction speed and acceleration (5-m sprint)	Second	1.38	0.21	1.41	0.08	-.03	0.37
Reaction speed and acceleration (10-m sprint)	Second	2.19	0.15	2.32	0.09	-0.13	2.39
Speed and agility test	Second	14.09	0.51	15.82	0.51	-1.73	**7.59***
Yo-Yo test	Meter	364.0	72.91	296.5	50.0	67.5	2.41

*t-value at .01 level of significance (18 df) for a two-tail test needed to exceed 2.878 for significance.

Table 7 indicates the changes in the four exercises used as the ultra-short game-pace exercises in the USGPT group's training regimen. All exercises improved significantly being evidence that the USGPT experience was very effective.

TABLE 7. PERFORMANCE CHANGES IN THE FOUR USGPT EXERCISES USED AS ONE EXPERIMENTAL TREATMENT.

Exercises	Pre-test measurement		Post-test measurement		Mean difference	*t* value*
	M	SD	M	SD		
Box agility	43.79	5.15	41.30	5.07	2.49	**7.20***
Defense slide drill	37.7	3.86	35.41	3.28	2.29	**8.01***
Beat the clock	76.42	12.45	64.66	12.20	2.76	**7.45***
2-cone weave drill	37.24	2.37	35.47	2.55	1.77	**8.02***

*t-value at .01 level of significance (9 df) for a two-tail test needed to exceed 3.250 for significance.

Discussion

This investigation was a pilot study because of several features. It is the first study using USGPT as an independent variable. Not knowing if the study-outcome would be in accordance with theoretical proposals was a major reason for grasping the opportunity of using serious, high-level female basketball players for the research endeavor. One major delimitation of the study is that convenient intact-groups were used. A common underlying assumption of group investigations is that participants are randomly assigned to groups so that any pre-study group differences occurred by chance alone. An attempt was made to assuage that shortcoming by comparing the pre-treatment measures on all independent variables. Table 3 shows there were no significant differences between the two groups on any of six variables. The pre-treatment scores of both groups were similar. The groups were "matched". The commonality between the two intact groups enhanced the likelihood that any inferences from significant findings would be correct.

A further assumption in investigations using parametric statistics is that the sample groups are distributed normally. This is a fairly robust assumption and normally only comes in to play when samples are markedly skewed or small. Because of small sample sizes, the data of both groups on every variable were pooled and the resulting pools of information tested for normality. Table 2 illustrates that each variable's distribution was within the bounds of acceptable normality. Thus, it is contended that despite the use of intact groups, pre-existing violations of theoretical assumptions were at most minor, but still have a remote chance of being peculiar enough to cast doubt over any significant findings. The threat of an increased likelihood of type I errors because of multiple t-tests was somewhat alleviated by increasing the stringency of the significant level from .05 to .01.

The effects of 12 weeks of traditional supplementary training on basketball players' test performances were modest at best (see Table 4). Two test results (vertical jump, reaction-time and acceleration at 10-m) showed significant changes. The other tests showed only small changes. On the other hand, the USGPT group changed significantly in the six test outcomes (see Table 5). That difference suggests that USGPT has greater and more varied training effects on female basketball players' locomotor abilities than traditional single physical-capacity training programs. However, when the post-treatment data of both groups were compared (see Table 6), only the *Test 17* and speed and agility tests were significantly different. When the actual mean performances of both groups were compared, the USGPT group recorded better improvements in times and performance amplitudes for all tests.

In practical sport settings, coaches very often consider any performance change to be better than no change and the best changes to also be the better even if the changes are not statistically significant in their differences. Thus, the effectiveness for producing better results from USGPT training when compared to traditional-training effects on all tests would likely be accepted as an important improvement in supplementary training formats for female basketball players. Coaches usually would willingly switch training programs if given sufficient guidance on how to change and the content of a sport-specific USGPT program. Currently, such a guide is only available for swimming (Rushall, 2016) but the concept and structure of USRPT activities is reasonably straight-forward.

The structure of this experiment was such that the initial test measures were taken before serious training/competing began. The post-treatment scores reflected the training effects gained from the supplementary training program plus improvements that could be attributed to all the other basketball related activities that occurred. This should be remembered when comparing pre- and post-treatment scores.

The four supplementary-basketball activities used as the training items for USGPT improved over the duration of the study (see Table 7). Those improvements were, in part, due to USGPT's requirement that athletes strive to improve their previous best performance every time the activity is repeated. That seems to have worked in this case. However, the four activities had time as the dimension used as assessment. As times improve, improvements become harder and harder to achieve. It is not possible to discern how impressive are the changes registered in these four activities. What was demonstrated here was yet another validation of *improvements only occur in the activities practiced* (i.e., the *Specificity of Training Principle*) when considering the performances of serious athletes.

The motivation for this study was the impressive substantive research bases and use of applied scientific principles that established USRPT as a better way of training mental, biomechanical, and physical sporting attributes than entrenched traditional training formats. This study focused on only the physical training of attributes that are commonly accepted performance features which are important for improving basketball performances. The training performed by the traditional-training group mainly involved resistance exercises (e.g., free weights, body weight, resistance machines) that were supposed to develop a single performance attribute (reaction-speed, acceleration, speed, and agility) at a time. While many conditioning programs involve specific exercises to develop performance factors, rarely do sport performances require associated single physical factors in their execution. It has long been recognized that an axiom of motor learning/training in serious athletes is that training only improves the activities performed in training[4]. Basketball certainly requires a multi-capacity form of activity and so supplementary physical training should employ as many simulations of game actions, segments, and situations as possible.

Traditional training using standard exercises (e.g., strength training for speed, repeated vertical jumps) often includes stationary activities which would have little benefit for basketball players. The use of strength activities to develop speed and reaction-time is based on an uncorroborated myth. Similarly, full-depth vertical jumps rarely occur in a game. The type of jump used when fighting for a rebound, or participating in a jump-ball, is not that of a deep vertical jump. As well, the common format of organizing traditional specific-exercises (e.g., three sets of 10 repetitions) does not guarantee any training effect that would lead to performance improvement. If the three sets of repetitions were all completed using the movements required, then the experience would not have been an overload experience, particularly if they were all completed comfortably. Rather, the exercise performance would have been sub-maximal. Any exercise that does not generate sufficient overload to cause the neural/technique features of a performance to falter is too easy to be of much value to a serious athlete. Much land-based supplementary training produces few overload experiences and mainly develops some accumulated general fatigue which could not be used to benefit specific performances for a particular game, such as basketball. It is no wonder that in this study the traditional-training supplementary physical program changed measured variables only marginally. The two variables that did change (vertical jump and reaction-time and acceleration at 10 meters) could well have been influenced by the non-supplementary

[4] For beginners and new participants in sports, the use of drills and specific exercises are often appropriate for developing the basic skills necessary for some form of participation. That teaching option is inappropriate for serious performers in whom most aims are to improve or refine skills, develop appropriate mental skills for competing effectively, and establishing the highest level of specific-energy resources possible. The Principle of Specificity is very important for the training experiences of serious athletes but not nearly as important for new entrants into the sporting realm. However, even for beginners, the activities performed should be related in part or in whole to later skill repertoires and performance requirements.

training (the general basketball activities in practices) as much as and possibly more so than the specific-physical training activities.

The USGPT group performed whole-body movement exercises which better replicate the speed and agility demands of a basketball game. The USGPT requirement of performing an exercise until performance fails to equal or surpass an individual pre-determined level that is appropriate for every player is very likely to produce a training effect. Since USGPT exercises are also performed at a high intensity, the speed of the trained movements is likely to be enhanced. In the general literature of high-intensity interval-training and ultra-short training, the volume of movement cycles that are completed in a training session are a great deal more than those programmed for traditional training or experienced from prescribed exercise amounts. The face-validity for USGPT being more effective than traditional training is strong. The research evidence of the effectiveness of USGPT elements is even stronger (Rushall, 2014). In this investigation it was found that USGPT + general training effects from other activities yielded better results than traditional training + general training effects.

Some of the analyses were confusing. The pre- versus post-treatment comparisons for traditional training yielded only two of six variables to be significantly different (see Table 4). In contrast, the USGPT pre- versus post-treatment comparisons showed all variables to have improved significantly (see Table 5). However, when the post-treatment scores of both groups were compared, only two variables were significantly different (see Table 6). Taken by themselves, the USGPT gains were very impressive while the traditional-training gains were possibly disappointing (particularly in the minds of individuals who advocate traditional supplementary training as a valuable adjunct to normal basketball training). Why the post-treatment group comparisons were not more impressive could be due to the moderate to weak power of the statistical test using samples of only 10 subjects.

This study was a pilot investigation to see if the ultra-short sport-intensity training model would be useful for basketball players. The improvements of the USGPT treatment group in all tests were very impressive. In comparison, traditional supplementary-physical training did not provoke as man significant improvements in the dependent variables. USGPT could be an advancement in the training of female basketball players and basketball players in general if more stringently planned research investigations were undertaken.

Conclusions

1. The USGPT supplementary training method for the development of physical attributes associated with the playing of basketball was impressive for developing the attributes of reaction speed, acceleration, agility, and muscular explosiveness (vertical jump).
2. Traditional supplementary training did not improve reaction speed, speed, agility, and acceleration to the same degree as did USGPT.
3. In this investigation, there were no different training effects between USGPT and traditional training for reaction speed, acceleration, and muscular ability (vertical jump).

Recommendations

1. The USGPT method should used to improve the performance qualities of female basketball players.

2. Further research into the effectiveness of USGPT should be conducted to evaluate it alongside other forms of supplementary training and with more diverse groups (e.g., males, different age groups, varying competition levels).
3. Further research should involve more diverse forms of assessment to adjudge the universality of USGPT effects.

References

Abdelkrim, N. B., Fazaa, E. E., & Atil, J. E. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British Journal of Sports Medicine, 41(2),* 69-75.

Abdelkrim, N. D., Chaouachi, A., Chamari, K., Chtara, M. & Castagna, C. (2010). Positional role and competitive-level differences in elite-level men's basketball players. *Journal of Strength & Conditioning Research, 24(5),* 1346-1355.

Astrand, I., Astrand, P-O., Christensen, E. H., & Hedman, R. (1960). Intermittent muscular work. *Acta Physiologica Scandinavica, 48,* 448-453.

Boone, J. & Bourgois, J. (2013). Morphological and physiological profile of elite basketball players in Belgium. *International Journal of Sports Physiology and Performance, 8*, 630-638.

Castagna, C., Impellizzeri, F. M., Rampinini, E., D'Ottavio, S., & Manzi, V. (2008). The Yo–Yo intermittent recovery test in basketball players. *Journal of Science and Medicine in Sport, 11(2),* 202-208. [http://www.jsams.org/article/S1440-2440(07)00085-0/fulltext]

Christensen, E. H. (1962). Speed of work. *Ergonomics, 5,* 7-13.

Christensen, E. H., Hedman, R., & Saltin, B. (1960). Intermittent and continuous running. *Acta Physiologica Scandinavica, 50,* 269-286.

Cormery, B., Martciland, M., & Bouvard, M. (2008). Rule change incidence on physiological characteristics of elite basketball players: A 10-year period investigation. *British Journal of Sports Medicine, 42(1)*, 25-30.

Crisafulli A., Melis F., Tocco F., Laconi P., Lai C., & Concu, A. (2002). External mechanical work versus oxidative energy consumption ratio during a basketball field test. *The Journal of Sports Medicine and Physical Fitness, 42(4),* 409-417. [http://www.minervamedica.it/en/journals/sports-med-physical-fitness/article.php?cod=R40Y2002N04A0409]

Drinkwater, E. J., Pyne, D. B., & McKenna, M. J. (2010). Design and interpretation of anthropometric and fitness testing of basketball players. *Sports Medicine, 38(7),* 565-578.

Hewett, T. E., Zazulak, B. T., Myer, G. D, & Ford, K. R. (2005). A review of electromyographic activation levels, timing differences, and increased anterior cruciate ligament injury incidence in female athletes. *British Journal of Sports Medicine, 41(2),* 69-75. [http://bjsm.bmj.com/content/39/6/347]

Howat, R. C. & Robson, M. W. (June, 1992). Heartache or heartbreak. *The Swimming Times,* 35-37.

Hunter, G. R.; Hilyer, J., & Forster, M. A. (1993). Changes in fitness during 4 years of intercollegiate basketball. *Journal of Strength & Conditioning Research, 7(1),* 26-29.

Mandelbaum, B. R., Silvers, H. J., Watanabe, D. S., Knarr, J. F., Thomas, S. D., Griffin, L. Y., Kirkendall, D. T., & Garrett, W. (2005). Effectiveness of a neuromuscular and proprioceptive training program in preventing anterior cruciate ligament injuries in female athletes. *American Journal of Sports Medicine, 33(7),* 1003-1010.

Margaria, R., Edwards, H. T., & Dill, D. B. (1933). The possible mechanism of contracting and paying the O_2 debt and the rate of lactic acid in muscular contraction. *American Journal of Physiology, 106,* 689-715.

McInnes, S. E., Carlson, J. S., Jones, C. J., & McKenna, M. J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sports Sciences, 13(5),* 387-397.

Myer, G. D., Ford, K. R., & Hewett, T. E. (2004). Rationale and clinical techniques for anterior cruciate ligament injury prevention among female athletes. *Journal of Athletic Training, 39(4),* 352-364.

Myer, G. D., Ford, K. R., & Palumbo, J. P. (2005). Neuromuscular training improves performance and lower-extremity biomechanics in female athletes. *Journal of Strength & Conditioning Research, 19(1),* 51-60.

Olsen, O. E., Meklebust, G., Engebretsen, L., Holme, I, & Bahr, R. (2005). Exercises to prevent lower limb injuries in youth sports: Cluster randomised controlled trial. *British Medical Journal, 330,* 449.

Padua, D. A. & Marshall, S. W. (2006). Evidence supporting ACL-injury-prevention exercise programs: A review of the literature. *Athletic Therapy Today, 11(2),* 11-23.

Paterno, M. V., Myer, G. D., Ford, K. R., & Hewett, T. E. (2004). Neuromuscular training improves single-limb stability in young female athletes. *Journal of Orthopaedic and Sports Physical Therapy, 34(6),* 305-316.

Quinn, E. (2014). 6 scientific rules that lead to fitness – 6. The Principle of Specificity. *Verywell.* [https://www.verywell.com/the-6-scientific-rules-you-must-follow-to-get-fit-3120111]

Rushall, B. S. (2011). Swimming energy training in the 21st Century: The justification for radical changes (Second Edition). *Swimming Science Bulletin, 39.* [http://coachsci.sdsu.edu /swim/bullets/energy39.pdf]

Rushall, B. S. (2013). The mechanisms of ultra-short training: The translation of Christensen's thinking into swimming terms and its place in training programs. *Swimming Science Bulletin, 45g*. [http://coachsci.sdsu.edu/swim/bullets/45g%20MECHANISMS.pdf]

Rushall, B. S. (2014). Ultra-short race-pace training and traditional training compared. *Swimming Science Bulletin, 43*. [http://coachsci.sdsu.edu/swim/bullets/Comparison43.pdf]

Rushall, B. S. (2016). Step-by-step USRPT planning and decision-making processes and examples of USRPT training sessions, microcycles, macrocycles, and technique instruction - Version 2.2. *Swimming Science Bulletin, 47.* [http://coachsci.sdsu.edu/swim/bullets/47GUIDE.pdf]

Rushall, B. S. (2017). Ultra-short Race-pace Training articles. *Swimming Science Bulletin, Table of Contents.* [http://coachsci.sdsu.edu/swim/usrpt/table.htm]

Rushall, B. S. & Pyke, F. S. (1991). *Training for sports and fitness*. Melbourne, Australia: Macmillan of Australia.

Sayers, S. P., Harackiewicz, D. V., Harman, E. A., Frykman, P. N., & Rosenstein, M. T. (1999). Cross-validation of three jump power equations. *Medicine & Science in Sports & Exercise, 31(4),* 572-577.

Schmidt, R. A., & Bjork, R. A. (1992). New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological Science, 3(4),* 207-218.

Schmidtbleicher, D. (1992). Training for power events. In P. V. Komi (ed.), *The Encyclopaedia of sports medicine: Strength and power in sport* (pp. 169–179). Oxford, UK: Blackwell.

Sigmon, C. (2003). *52-week basketball training (52-week sports training series)*. Champaign, IL: Human Kinetics Publishers.

Spencer, M., Bishop, D., Dawson, B., & Goodman, C. (2005). Physiological and metabolic responses of repeated-sprint activities. *Sports Medicine, 35,* 1025-1044.

Stasinopoulos, D. (2004). Comparison of three preventive methods in order to reduce the incidence of ankle inversion sprains among female volleyball players. *British journal of Sports Medicine, 38(2),* 182-185.

Steinhöfer, D. (2008). *Athletiktraining im Sportspiel:. Theorie und Praxis zu Kondition, Koordination, und Trainingssteuerung*. Muenster: Philippka.

Tavino, L. P., Bowers, C. J., & Archer, C. B. (1995). Effects of basketball on aerobic capacity, anaerobic capacity, and body composition of male college players. *Journal of Strength & Conditioning Research, 9(2),* 75-77.

Taylor, J. A. (2004). Tactical metabolic training model for collegiate basketball. *Strength Conditioning Journal, 26,* 22–29.

Thompson, D. O. (2014). In reply to Dan McCarthy's article, "Addressing Ultra-short Race-pace Training". *Swimming Science Bulletin*, 48. [http://coachsci.sdsu.edu/swim/bullets/ 48Reply.pdf].

Young, W. B., McDowell, M. H., & Scarlett, B. J. (2001). Specificity of sprint and agility training methods. *Journal of Strength & Conditioning Research, 15(3),* 315-319.

Zatsiorsky, V. M. (1995). *Science and practice of strength training*. Champaign, IL: Human Kinetics.