The Effects of Pre-Season Resistance Training Program on Fitness Profile of Female University Softball Players

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ABSTRACT: The game of softball is essentially skill related and needs perfection in throwing, catching, hitting and bases running skills. In addition to technical and tactical skills, muscular strength and power are important factors that give clear advantage for successful participation and performance during tournaments. Strength and conditioning programs for collegiate female athletes are important in helping to prepare them for the sport season, and being incorporated into training schedule can facilitate subsequent improvements in skills and technique. The purpose of this study was to investigate the effects of resistance training program on fitness profile of female university softball players. A total of 20 healthy female university players were involved in this study. All subjects completed pre-test assessments followed by 6 weeks of intervention training for experimental group (n=10), similar duration of the standard training for control group (n=10) and post-test assessments. Fitness tests included 30m run, sit ups, modified push-ups, standing broad jump, 6x10m agility shuttle run and softball throw. Independent and dependent *t*-test analyses were administered to compare the effects of administered training within and between the groups. Both groups demonstrated significant improvements at post-test assessment, most parameters in experimental group however showed superior improvements as compared to the control group at the time of the post- testing.

Keywords: Resistance training; female softball players; fitness profile.

INTRODUCTION

Softball is a sport that demands basic power, strength, quickness and endurance [1]. Strength and power are the integral components of a softball player's defensive and offensive performances on the field; with throwing velocity recognised as an important determinant of success in baseball [2]. Softball places unique demands on an athlete to repeatedly produce bouts of speed and power efforts over short distances. Having this in mind, improvements in strength and power could be the driving force behind success in this increasingly popular and competitive sport [3]. Besides, in order to increase the potential of a softball player, one must be effective in performance-related conditioning that would directly benefit the skills of throwing, hitting and fielding. Improving power for hip rotation enhances hitting, and fielding is enhanced through improving foot speed and agility [4]. The strength and conditioning program for collegiate female athletes is a tool in helping them to prepare for the tournament season where common goals include increased level of performance and decreased number of injuries.

Specialists note that when training for optimal softball performance, priorities in the conditioning program should include lower-body strength and agility, upper-body strength, abdominal strength, and endurance [4].

Since the velocity of a softball throw is dependent on the athlete's ability to develop maximal force rapidly [5], and time is limited during the throwing action the muscles involved must exert as much force as possible, with the rate of force development becoming a contributing factor (6). Thus, to increase power with a stable technique, it is important to improve either the force applied to the ball or the speed of muscle contraction or both factors simultaneously [7, 8]. De Renne *et al.* [9] advise that when designing resistance training programs for softball players, the exercises should include trunk, lower body and arm muscles.

As most of the movements in softball are rotational in nature (be it hitting, throwing or pitching), strength training of the core musculature may help in the transfer of forces from the lower extremity to the throwing arm. Trunk development is vital to sport-specific training in softball, since softball players need good trunk and lower body development to transfer power to hitting. Explosive movements and rapid rotation of the trunk are common in softball. These motions are initiated in the hips and legs [10]. Exercises focused on the accumulation of relative strength must also encourage neuro-muscular coordination of effort in forming of the conditioned reflex ties [11].

Overall strength and power for throwing, hitting and running may be increased by performing general strength exercises [9]; and according to the basic periodized training model, preparatory period (or pre-season) is considered the right time to improve on strength and conditioning of an athlete [3]. Pre-season conditioning for collegiate female athletes is important in helping to prepare for the sport

season [12] where the increased need for technical training and tournament participation diminishes in-season conditioning to basic maintenance of the adequate levels of strength and power [13].

The objective of this study was to investigate how resistance training influences the University female softball players' pre-season fitness profile.

MATERIALS AND METHODS

Sample

Required for the study sample size was calculated using PS-Power and Sample Size Calculation software. The power of the study was set at 0.80 with 95% confidence interval and α was set at 0.05. With previously reported standard deviation of 0.65 and expected effect size at 0.9, the minimal total required sample size equaled n=18 which, adjusted to a possible dropout rate of 10%, came up to 20 participants.

Hence a total of 20 healthy female university softball players with at least one year of competitively playing the game experience were recruited for this study. All recruited subjects were the students of University Science Malaysia aging from 19 to 22 years in training for inter-varsities competitions and some for the Malaysian University Council of Sports competitions. All subjects had no chronic illnesses or known conditions during the whole study period. During the recruitment, subjects signed participant information and consent form. All the details of the study such as purpose, testing procedures, training regimes, period of involvement, risks, benefits, and discomforts throughout the study and the freedom of participant to withdraw were included in the consent form. The study protocol was approved by the research and ethics committee of the Universiti Sains Malaysia.

Testing protocol

The anthropometry tests included measurements of height, weight and body composition. Measurements were done with the help of Omron Karada Scan (Japan) machine and Seca Body Meter. Players also attended to the physical fitness tests including 30m run (s), 1 min modified push-ups (n), 1 min sit-ups (n), standing broad jump (cm), softball throw (m) and 6x10m shuttle run (s).

After the pre-intervention assessments participants were randomly assigned to experimental and control groups (10 subjects each). Six weeks intervention training was offered to experimental group whereas control group followed their regular routine for the same period of time. Intervention training program was first formulated for three weeks, and further adjusted for three more weeks in step with the pre-season training objectives. The post-intervention assessment was administered using the same tests, testing equipment and test sequence as the pre-tests.

Training Protocol

Training for the control group was arranged as shown in Table 1 for the whole duration of the intervention period. It was typically organized in a specific manner with basic skills, game-related drills and game elements represented in every session of the program.

Table 1. Control group training routine

Sunday	Monday	Tuesday	Wednesday	Thursday
Warm up–20 min	Warm up–20 min	Warm up–20 min	Warm up–20 min	Warm up–20 min
Throwing–20 min	Throwing–20 min	Throwing–20 min	Throwing–20 min	Throwing–20 min
Batting – 30 min	Game drills – 40 min	Play game – 40 min	Batting – 30 min	Game drills – 40 min
Game situations – 10 min	Cool down – 10 min	Cool down – 10 min	Game situations – 10 min	Cool down – 10 min
Cool down–10min			Cool down–10min	
Total 90 min	Total 90 min	Total 90 min	Total 90 min	Total 90 min

Training for the experimental group for weeks 1 to 3 was fixed as shown in Table 2, with 2 sessions a week dedicated to strength and conditioning. Sessions involved two different exercise programs, with one consisting of Bench Press, Lateral Raise, Overhead Sitting Press, Squats, Barbell Curls, French Press, Upper abdomens, and Hyperextensions/ Pull ups; and another one consisting of Dead Lift, Squats, Hamstring, Narrow Grip Bench Press, Overhead Press, Front Rise, Reverse Biceps, Lower Abdomen and Hyperextensions /Pull ups. Each exercise was performed in 12-15 reps (except for Abdomens and Hyperextensions /Pull ups, which were performed to the maximal number possible) and 2 sets. Rest intervals were set at 90 sec between sets and 2 min between exercises.

Table 2. Experimental group training routine weeks one to three

Sunday	Monday	Tuesday	Wednesday	Thursday
Warm up–20 min	Warm up–15 min	Warm up–20 min	Warm up–15 min	Warm up–20 min
Throwing–20 min	Game drills – 25 min	Throwing–20 min	Batting – 15 min	Throwing–20 min
Batting – 30 min	**Conditioning** – 40 min	Play game – 40 min	Game situations – 10 min	Game drills – 40 min
Game situations – 10 min	Cool down – 10 min	Cool down – 10 min	**Conditioning** – 40 min	Cool down – 10 min
Cool down–10min			Cool down–10min	
Total 90 min	Total 90 min	Total 90 min	Total 90 min	Total 90 min

After the completion of three weeks of experimental training, further training for the remaining period of another three weeks was adjusted as described in Table 3. Adjusted conditioning programme for three concluding weeks featured the extra field conditioning programme, in addition to the gym ones maintained from the beginning. Field session (on Sunday) included Striding (40-50 m), Frog jumping (40-50m), Wheelbarrow (in pairs, 30 m each), Hopping (20 m on each leg), Low hurdles (1 m apart) jumping (12 –15 Nos) and once more a Wheelbarrow (as above) as one set. Rest intervals were arranged as 1min jog between exercises and 4 min of relaxation exercises between the sets. Total 3 sets were performed in a session with ten minutes rest after the last set followed by 2 min of rope skipping.

Table 3: Experimental group training routine weeks four to six

Sunday	Monday	Tuesday	Wednesday	Thursday
Warm up–20 min	Warm up–15 min	Warm up–20 min	Warm up–15 min	Warm up–20 min
Throwing – 10 min	Games drills – 25 min	Throwing – 20 min	Batting – 15 min	Throwing – 20 min
Conditioning – 40 min	**Conditioning** – 40 min	Play game – 40 min	Game situation – 10 min	Games drills – 40 min
Game situation – 10 min	Cool down – 10 min	Cool down – 10 min	**Conditioning** – 40 min	Cool down – 10 min
Cool down–10min			Cool down–10min	
Total 90 min	Total 90 min	Total 90 minutes	Total 90 min	Total 90 min

Statistical Analyses

Independent and paired *t*-test analyses were administered to compare the effects of administered training within and between the groups. The analysis was made using SPSS version 19.0 computer software.

RESULTS AND DISCUSSION

Demographic data

All subjects have successfully completed the 6 weeks training intervention including pre- and post-tests scheduled for this study. Basic demographic and anthropometry data from the subjects are summarized in Table 4.

Table 4. Demographic and anthropometric characteristics of the subjects

Variable	Control Group		Experimental Group	
	Pre Test (mean±SD)	Post Test (mean±SD)	Pre Test (mean±SD)	Post Test (mean±SD)
Age (Years)	19.70 ± 0.68	19.70 ± 0.68	20.4 ± 1.08	20.4 ± 1.08
Height (cm)	153.57 ± 6.09	153.57 ± 6.09	155.95 ± 4.43	155.95 ± 4.43
Weight (kg)	50.85 ± 8.56	50.68 ± 8.33	50.33 ± 2.94	50.17 ± 2.88
BMI ($kg.m^{-2}$)	21.35 ± 2.61	21.5 ± 2.83	21.69 ± 1.23	20.56 ± 0.99
Fat (%)	25.39 ± 3.39	26.76 ± 4.80	26.07 ± 3.89	25.54 ± 3.93

No statistically significant differences between pre- and post-tests were observed in either group.

Effects of training on physical fitness variables in control group

Analysis of the pre- to post- dynamics of the assessed fitness variables in control group has revealed significant improvements in strength endurance, power and agility resultant from the 6 weeks of specific softball training.

Speed, on the contrary, deteriorated however insignificantly (Table 5).

Table 5. Physical fitness variables of the control group from pre- to post tests

Motor quality	Test performed	Pre Test (mean ± SD)	Post Test (mean ± SD)	*p*-value
Speed	30m Run (s)	6.29 ± 0.45	6.35 ± 0.42	0.618
Strength endurance	Modified push-ups (*n*)	16.0 ± 2.16	19.2 ± 2.20	0.004*
	Sit ups (*n*)	14.4 ± 2.91	16.5 ± 3.54	0.012*
Power	Standing Broad Jump (m)	1.36 ± 0.19	1.43 ± 0.19	0.033*
	Softball Pitching Throw (m)	10.54 ± 2.53	12.29 ± 2.33	0.025*
Agility	Shuttle Run 6 x 10m (s)	21.39 ± 1.88	19.74 ± 1.70	0.004*

*$p \leq 0.05$

Effects of training on physical fitness variables in experimental group

Analysis of the pre- to post- dynamics of the assessed fitness parameters in experimental group has revealed significant improvements in all tested variables, including speed, strength endurance, power and agility as a result of 6 weeks of conditioning incorporated training (Table 6).

Table 6. Physical fitness variables of experimental group

Motor quality	Test performed	Pre Test (mean ± SD)	Post Test (mean ± SD)	*p*-value
Speed	30m Run (s)	6.38 ± 0.61	6.05 ± 0.68	0.000*
Strength endurance	Modified push-ups (*n*)	16.0 ± 2.90	22.2 ± 3.12	0.000*
	Sit ups (*n*)	15.0 ± 3.30	20.2 ± 2.86	0.000*
Power	Standing Broad Jump (m)	1.34 ± 0.11	1.43 ± 0.14	0.012*
	Softball Pitching Throw (m)	12.84 ± 3.37	17.96 ± 2.13	0.001*
Agility	Shuttle Run 6 x 10m (s)	20.81 ± 1.28	18.28 ± 0.86	0.000*

*$p \leq 0.05$

Obviously, both training programs had positively influenced physical fitness profile; speed however improved only as a result of conditioning incorporated program. To investigate into which of the two programs facilitated superior improvements, independent *t*-test was administered for the post-test data analysis.

Post-test comparison of fitness variables in control and experimental groups

After running the post-test comparison, significant differences were observed between fitness variables of control and experimental groups at the post-intervention testing (Table 7).

Table 7. Post-intervention comparison between control and experimental groups

Motor quality	Test performed	Control (mean ± SD)	Experimental (mean ± SD)	*p*-value
Speed	Maximal 30m Run (s)	6.35 ± 0.42	6.05 ± 0.68	0.247
Strength endurance	Modified push-ups (*n*)	19.2 ± 2.20	22.2 ± 3.12	0.023*
	Sit ups (*n*)	16.5 ± 3.54	20.2 ± 2.86	0.019*
Power	Standing Broad Jump (m)	1.43 ± 0.19	1.43 ± 0.14	0.990
	Softball Pitching Throw (m)	12.29 ± 2.33	17.96 ± 2.13	0.000*
Agility	Shuttle Run 6 x 10m (s)	19.74 ± 1.70	18.28 ± 0.86	0.026*

*$p \leq 0.05$

Conditioning incorporated training has proven significantly superior to the traditional soft ball specific training in modified push-ups, sit-ups, pitching throw and 6x10m shuttle run. It however has not been more advantageous to the traditional training in standing broad jump.

Conducted study has overall confirmed that young female softball players improve their physiological capacities with training [1] and also in such a short period of time as 6 weeks. Anthropometric variables have not changed significantly, for 6 weeks obviously being too short a time to expect any.

Proposed conditioning incorporated training proved significantly superior to the traditional soft ball specific training in strength endurance (by the results of modified push-ups and sit-ups), power (by pitching throw) and agility (by 6x10m shuttle run). Other assessed fitness components however were not superiorly impacted by conditioning incorporated program; specifically power (standing broad jump). Results obtained on the physical fitness of the experimental group indicate that all variables significantly improved from the pre-test, possibly due to the conditioning training that has been provided. Observed improvements are in line with the results by Marques *et al.* [13] confirming that strength and power are among important factors for successful participation in competitions.

Counting the short term intervention nature in our study, observed improvements could be due to the improvements of neuromuscular control, proprioception, and coordination [14]. Observed in the study fitness improvements could positively influence coordination important to perform the drills and the soft ball distance throw like in case of our study [15].

Softball throw distance in both groups showed significantly improved results. Besides the difference in the significance level between the control and experimental groups, the latter was significantly superior over the control group at the post-test. Means of softball throw for control and experimental groups post-intervention were at 12.29±2.33 and 17.96±2.13 respectively with *p*-value of 0.000. With obvious improvements, the study subjects however were still at the average standard. Few of the parameters of the control group has also shown significant improvements from the pre-test but not higher than in the experimental group. Comparative analysis between the control and experimental groups has demonstrated overall superiority of the conditioning incorporated training over the standard softball training in university softball female players.

Only two out of the tested parameters haven't shown significant differences from the control group at the post-test level: maximal speed and power, expressed in the 30m run timing and standing broad jump. This however was not surprising, since implemented training was supposed to serve as a starting block for further speed and power development on the way towards the early season competitions.

On the other hand, six weeks of experimental training happened to be enough to elicit significant changes in strength endurance (sit-ups and pushups) agility (6x10m shuttle run), and upper body power (softball throw).

SUMMARY

It can be summarized, that although both specific and conditioning incorporated training brought certain improvements to the university softball players' fitness profile. Conditioning incorporated training, however, improves more fitness variables and in most of them tends to be superior. Although resistance training brought in significant speed improvements within the six weeks training intervention, it happened to be insignificantly different from the post-test result of the control group trained traditionally. The magnitude of the improvements in both groups has to be perhaps partially attributed to the originally not a very high fitness level of the subjects in this study. Hence the initial values principle could have contributed to the facilitation of superior improvements in less fit individuals.

Further research is needed to determine the sufficient period of intervention required to improve maximal speed and power of lower extremities in female softball university players.

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