Original Article

Effect of training program on physical performance in junior male Malaysian soccer players

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Abstract

Purpose: The purpose of the present study was to investigate the effect of a training program on physical performance in junior male soccer players.

Methods: Twenty five players (mean age = 13.28 ± 0.45 years), were randomly assigned to either an experimental group (n-13) or a control group (n-12). The experimental group followed the warm-up training program, 5 days per week for 12 weeks. The control group performed the usual warm-up training. Before, middle and after the intervention, both groups performed a battery of soccer-specific physical tests, including (1) Standing long jump test (explosive leg power), (2) Sargent jump test (vertical leg power), (3) Illinois agility test (agility), (4) Prone hold test (core stability/abdominal muscle endurance), and (5) Running speed test (speed). Data were analyzed by Repeated Measures ANOVA for comparison between groups to evaluate the changes over time.

Results: At the end of the intervention the experimental group showed superior changes compared to the control group for explosive leg power (12.85% vs 1.58%), vertical leg power (18.45% vs 3.78%), agility (-4.49% vs 0.76%), muscle endurance (98.85% vs 8.08%) and running speed (- 6.16% vs 1.11%).

Conclusions: These findings demonstrate that the warm-up training program is an appropriate and effective tool for improving soccer-specific physical performance characteristics of junior soccer players.

Key words: children, warm-up, football, speed, agility.

Introduction

Soccer is a known sport that demands a high level of physical ability and skillful movements. The most important activities while playing soccer in a 90-minute duration involved predominantly running, explosive sprinting, jumping, kicking, and changing direction repeatedly (Krustrup et al., 2005; Stølen et al., 2005). These activities will definitely require good functioning of the neuromuscular systems (Cometti et al., 2001). Thus, it is such an important target that all players develop their highest functional capacity to enhance their linear sprinting, jumping, and agility (Hoare & Warr, 2000; Chamari et al., 2004).

Performance in soccer is dependent on the technical, tactical and physical skills (Hoff & Helgerud, 2004) that can be accomplished if the players have good components of flexibility, endurance, strength, speed and agility. These categories are not completely distinct from each other, and physical interventions or training may improve performance in more than one component at the same time (Kraemer & Hakkinen, 2000). In adults, Sedano et al. (2011) have reported the significant benefits of physical interventions in the soccer performance, particularly with respect to the effective training stimulus that improved explosive strength and kicking speed. The effectiveness of exercise-based physical programs for enhanced performance had been shown in both younger adolescent male (Arazi & Asadi, 2011) and female football players (Chimera et al., 2004). However, there is a lack of study that have focused on children (juvenile) and youth (MacKay et al., 2004). It was highlighted by Emery et al. (2005) that a suitable training program for children and youths need to be designed. This is such an important issue in view of the importance of the types and effects of training that may be suitable with the growing stage.

A few studies have examined the effects of training programs on performance in children and adolescents, especially among female soccer players between 9 and 18 years of age (Hanna, 2011; Vescovi & Heest, 2010; Steffen et al., 2008 and Grandstrand et al., 2006), youth male and female soccer players (DiStefano et al., 2010), and boys at the age of ten (Kilding et al., 2008). The studies by Kilding et al. (2008) and DiStefano et al. (2010) showed slight improvements of some aspects of the soccer specific performance after completion of training programs, while other studies (Hanna, 2011; Steffen et al., 2008 and Grandstrand et al., 2006), did not

show any improvement at all, while another study (Vescovi & Heest, 2010) showed a temporary improvement of sprint times for longer distances.

Young adolescent players may be involved in a different kind of training programs that may predispose them to danger or ineffective training method. They may be attracted to participate in a training program that is supposed to be suitable only for mature athletes without knowing whether the dosage of the training volume is suitable to their age. In order to overcome such problems, providing athletes with one integrated and coordinated training plan becomes the priority (Christian, 2011). With the increase in the number of young players being recruited in a soccer team as well as those enrolled in a soccer academy at a very young age, the important agenda is to provide them with a safe and effective training program without overtraining the young athletes.

One such predominant exercise-based, that may be suitable and exclusively for junior soccer players is a proper design of “warm-up training program”. The training program comprises of eighteen physical exercises. The exercises included activities such as core stabilization, eccentric training for major muscles, proprioceptive training, dynamic stabilization and plyometrics. With this in mind, this study aimed to investigate the effect of a 12-week warm-up training program on a soccer-specific physical performance (explosive leg power, vertical leg power, agility, core stability and running speed) in junior male soccer players.

Methods

This is an experimental study involving pre-test, mid-test and post-test data collection, conducted during the second half of the 2012 soccer season. The junior soccer players from a selected sports school were recruited to participate in this study. The potential participants received a written and oral information about the study, and they were emphasized that participation is voluntary. All players were screened for any acute or chronic injuries using a questionnaire prior to the start of the study. Players who presented with injuries were excluded from this study. This resulted in the selection of a total of 25 subjects, who were randomized to an experimental group (n=13) and a control group (n=12). The subjects had a mean age of 13.28 ± 0.45 years, body mass index of 20.34 ± 1.21 kg/m², height 1.63 ± 0.06 m, with 4.40 ± 0.50 years of playing experience. The study was approved by the ethics committee, Universiti Teknologi MARA.

Physical performance tests

The subjects took part in a testing procedure at the start, during the middle and at one week after the end of the intervention, to assess the physical performance effects of the “warm up program”. The testing took place in the sports field at the Bukit Jalil Sports School. The test battery for the physical performance measures were completed within 3-4 hours. All tests were conducted by the same research assistant who was blinded to the subject's group. The researcher recorded the type of shoes used by each subject, to ensure that the same pair is used on all test days. The subjects performed the following tests, at the start, during the middle and at one week after the end of the 12 week intervention: (1) Standing long jump test, (2) Sargent jump test, (3) Illinois agility test, (4) Prone hold test, and (5) Running speed test. Prior to the physical performance tests, the researcher conducted a soccer-specific warming up. All measurements during pre-, mid- and post-tests were performed with the same sequence of testing and conducted at the same time of day ($15:00 \pm 0.5$ hrs) in the same venue.

Standing long jump test (SLJT)

The ability to produce explosive leg power may help in the production of a maximum sprinting and jumping effort while playing soccer (Bangsbo, 1993). In this study, the SLJT was used to measure the explosive leg power and followed the procedure as described by Castro-Pinero et al. (2010). The best score from three attempts was recorded as the subject's performance for explosive leg power.

Sargent jump test (SJT)

The ability to jump vertically may be required when trying to catch a high ball especially when the opponent is very close to the player, and in which, high short term muscle power is necessary (Chelly et al., 2009). The maximum vertical jump height was measured using the SJT. This involved several steps including warm-up for 10 minutes. The test was conducted according to the procedure as described by De Salles et al. (2012). The players repeated the test for 3 times with 15 rests in between trials. The average value from the 3 trials was used as the score for the vertical leg power.

Illinois agility test (IAT)

The ability to produce a quick movement while playing soccer will depend on the player's agility (Robinson & Owens, 2004; Yap & Brown, 2000). In this study, agility was determined using the IAT. The test was performed with the subject positioned in lying down with both hands next to the shoulders. Then, the subject got up and sprinted between and around the cones, back and forth, to touch the finishing line. The total time taken to complete the test was recorded using a stopwatch, and the mean of the best two times was used to assess the subject's performance for agility.

Prone hold test (PHT)

Good core stability is one of the most important components of most high level sports participation. According to Staron et al. (1994), higher core stability performance requires efficient nervous system functions, that may lead to better postural control especially during fast dynamic motion. In this study, the PHT was used to assess the core stability or the abdominal muscle endurance. The subject was asked to lie down while supporting

the body on the forearms and feet. The elbows were positioned right under the shoulders. Then, the subject lifted the body up (in a straight line) while pulling the stomach in and was instructed to hold the position as long as possible. The time taken to hold this position was recorded using a stopwatch. The score for PHT was based on a single trial only.

Running speed test (RST)

The ability to run at a high speed is necessary when trying to score goal or to stop a ball from being scored. Bangsbo (1993) suggested that by increasing the force of appropriate muscles and training speed, may improve skills for turning, sprinting, and changing pace during soccer. In this study, the running speed was tested based on time for running a single maximum sprint over 20 meters (RST). The test started from a stationary position, with one foot in front of the other and held for at least 2 seconds prior to running. The researcher assistant provided motivation for the subject to continue running hard till the finishing line. The average of two trials was recorded as the score for this test, in which an adequate recovery time (approximately 3 to 5 min) was allowed between the trials.

The protocol for warm-up training program

The training program was designed as a warm-up program exclusively for junior soccer players. The exercises were adapted from various recommendations for training the soccer-specific physical performance (BBC, 2002; F-MARC, 2005). The training consisted of 18 activities as shown in Table 1. These activities took about 20 to 25 minutes and did not require additional equipments. The subjects in the experimental group performed the training 5 times per week for 12 weeks. Once a week, the researcher briefed the players on the importance of compliance to the training schedule, safety and precautions, correct execution and techniques of training movements. All subjects in the experimental group were given a copy of "The warm-up training program" that was illustrated with pictures and the correct ways to perform the movements. The subjects in the control group were instructed to continue warming up as usual. This mainly involved jogging and ball based exercises.

Statistical Analyses

The independent t-test was used to test the homogeneity of groups' characteristics at baseline. Analysis of variance (ANOVA) with repeated measures were used to test changes over time between groups. A value of $P < 0.05$ was accepted as statistically significant changes. Data analysis was done using SPSS (version 19, Predictive Analytics Software).

Results

Both groups were found to be homogenous in terms of gender, age ($P > 0.05$), height ($P > 0.05$), weight ($P > 0.05$), and BMI ($P > 0.05$). It was also found that there were no changes to BMI after the intervention in both groups (Table 2). An examination on the training diaries revealed, on average, participants completed 4.6 ± 0.48 training times per week, and with an adherence rate of 92%.

In the present study, statistical analysis of repeated measures ANOVA showed that there was a significant difference between groups. The pre-, mid- and post-intervention results for both groups were presented in Table 1. Measures of leg power (SLJT and SJT) increased significantly [5.23 %, 12.85% ($P < 0.01$) and 8.72 %, 18.45 % ($P < 0.01$) respectively] in the experimental group, but not the control group. Whilst there was a tendency for both agility and core stability to improve in the experimental group [- 3.36%, - 4.89% and 33.41%, 98.85% ($P < 0.01$) respectively], but this was not significant when compared to changes in the control group. Similarly, speed over 20 m improved by -2.52 %, -6.16% ($P < 0.01$).

Table 1. Protocol for Warm-up Training Program

Exercise	Instructions	Exercise	Instructions
CORE STABILITY The Bench Static Rear Leg Raises Hip Circles (Prone) Pelvic Tilt into Bridge	Hold this position for 5s. Repeat 2-5 repetitions. Repeat 2-5 repetitions, switch side. Repeat 2-5 repetitions, switch to the other leg. Hold position for 5s. Repeat 2-5 repetitions.	PLYOMETRICS Jumps over a line Running quick forwards & backwards Groiners Running Bounding	Repeat side-side 5 times. Complete course (1) times. Repeat 2-5 repetition. Cover 15 meters (1) times.
BALANCE Standing Hip Circles Single - Leg stance Throwing Ball with Partner Single-Leg stance, Test your partner	Repeat 2-5 repetitions, switch to the other leg Hold position (10) sec. Change legs and repeat once. Repeat (8) times on each leg Continue for 10 sec. Change legs and repeat once.	STRENGTH Side Neck Stretch Standing Soleus and Achilles Stretch Windmills 90/90 Hamstring Runner's Stretch Lower Back Curt	Hold for 5s, switch side. Hold 5s and then switch to the other leg. Repeat 2-5 repetitions, switch to the other leg. Repeat for 2-5 repetitions, switch to the other leg Hold 5s and then switch to the other leg. Hold this position for 5s. Repeat 2-5 repetitions.

Table 2. Pre-, mid- and post-interventions data, and percent changes, for all measures in both the experimental and control group. Values are Mean ($\pm$ SD)

	EXPERIMENTAL GROUP (<i>n</i> = 13)					CONTROL GROUP (<i>n</i> = 12)					<i>P</i> -value
	Pre-test	Mid-test	Post-test	Δ% Pre-Mid Pre-Post		Pre-test	Mid-test	Post-test	Δ% Pre-Mid Pre-Post		
BMI (kg/m2)	20.74±1.54	20.85±1.61	20.88±1.57	0.48	0.62	19.90±.48	19.87±.53	19.86±.91	-	-	.061
Height (m)	1.62±.07	1.63±.08	1.64±.08	0.61	1.23	1.63±.05	1.64±.07	1.65±.06	0.15	0.20	.696
SLJT (m)	2.10±.11	2.21±.13	2.37±.14	5.23	12.85	2.08±.14	2.09±.15	2.11±.18	0.86	1.58	.017
SJT (cm)	.40±.03	.43±.05	.47±.03	8.72	18.45	.39±.04	.40±.04	.41±.03	1.26	3.78	.016
IAT (s)	16.96±.40	16.38±.36	16.12±.25	-3.36	-4.89	17.03±.37	16.92±.30	16.90±.28	-	-	.001
PHT (s)	53.15±7.88	70.92±7.49	105.76±8.10	33.41	98.85	55.66 ±6.21	58.08±7.10	60.16±6.52	0.64	0.76	.000
RST (s)	3.57±.22	3.48±.18	3.35±.08	-2.52	-6.16	3.59±.13	3.62±.14	3.63±.15	4.32	8.08	.026

$\Delta\%$ Percentage of change. $P < 0.05$ indicates significant changes.

Discussion

The results of the current study indicated positive changes in the performance for all the variables tested among the experimental group using the warm-up training as compared to the control group. The impact of the training program was reflected by significant changes in several of the physical performance abilities that can be primarily due to increases in the physical fitness as a result of the specificity of the training program. However, the insignificant changes in the BMI could be explained by the relatively short duration of the present intervention (12 weeks) that may not be long enough to cause changes in the children's growth and maturity.

In soccer performance, the ability to jump higher to head the ball in attacking or defensive situations is critical for scoring goals. Therefore, a training session for soccer players should consider the inclusion of activities that may enhance leg power. In the current study, the warm-up training program significantly increased the explosive leg power (Experimental = 5.23% to 12.85%; Control = 0.86% to 1.58%, both $P < 0.05$, Table 2). Likewise, the major enhancement was also observed in vertical leg power (Experimental = 8.72% to 18.45%; Control = 1.26% to 3.78%, both $P < 0.05$; Table 2). The improvement in these two performances in the experimental group could be attributed to the training program which have incorporated a component of plyometric activities. In soccer, leg power (the producer of power and speed) would likely be related to improved jumping and sprinting skill on the pitch.

As compared to earlier reviews, our study demonstrated that the large increase in improvement of jump (explosive leg power, vertical leg power) as compared to a study by Kilding et al. (2008), that showed only a slight improvement in jumping (3.4%, 6% respectively). While agility and core stability did not improve after performing the warm-up training program "The 11" five times per week for 6 weeks. Similarly, Steffen et al., (2008) who studied "The 11" for 10 weeks (three times per week), found no soccer performance improvements. The inconsistency in the current findings and previous studies could be due to the differences in terms of the study duration, frequency and adherence rate to the training programs.

Agility is an essential physical component that helps soccer players to dribble with ease to and get in front of the defender and finish on crosses (Wilmore, 1993). In this study, both groups showed significant changes in the agility test following the 12-week intervention (Experimental group = -3.36% to -4.89%, Control = -0.64% to -0.76%, both $P < 0.05$, Table 2). However, we considered the changes as very minimal. There is a lack of the element of agility training in the protocol for the warm-up program that could have led to the results. Probably the only training that may have improved the agility in the experimental group was the running quick forwards and backwards. Otherwise, both groups could have improved this performance solely from the usual soccer training. As such, we suggest that a training protocol should consider incorporating a design of agility training. An improvement in core stability and muscular endurance was also observed (Experimental = 33.41% to 98.85%; Control = 4.32% to 8.08%, $P < 0.05$ Table 2). In regular soccer, good muscular support, balance and core stability are all very important to maintain the integrity of the spine to support the body mass plus additional loads during resistance training and sports activities (Panjabi, 1992; Willardson, 2007). In addition, core stability also helps to maximize efficient balance and athletic function in upper and lower extremity movements (Kibler, 2006). In this study, we suggest that the large improvement in the experimental group was a direct benefit from the training program that have included activities for core stability. Normally, soccer players with good sprint skills or running speed have the advantage over other players (Harris et al, 2000).

In the present study, the warm up program resulted in improved speed with larger changes in the experimental group (-2.52% to -6.16%, $P < 0.05$) compared to the control group (0.83% to 1.11%, $P < 0.05$). However, Vescovi & Heest (2010) evaluated the effect of the PEP-program on performance and minor improvements was seen in sprinting performance after six weeks of training. Improvement in the running speed

could be associated with the benefit of the whole training protocol as it may have helped the muscles to maximize its strength and power.

Collectively, this study has shown that such program that incorporated important components for soccer performance may be effective, enjoyable and easy to be performed by young adolescent. This is concluded based on the high adherence rate and oral comments from the players in the intervention group. Most of them commented that they enjoyed doing the training activities and highlighted that most movements were easy to perform. Thus, it is recommended that soccer trainer should provide a variety of stimuli during training that may maximize adherence and enjoyment as well as prevent overuse injury. In order to determine the most suitable exercise training for this vulnerable age group, it is also advisable that medical professionals and physiotherapists be consulted so that a multidisciplinary approach can be incorporated in the training program. This is because the general increase in the body size through maturation must be considered when designing physical training programs for children (Dollard et al., 2006).

Conclusion

In conclusion, we present a multifaceted, soccer specific training program that combines, proper motion patterns, strength, and balance, without using any equipment other than a ball. In addition, the results of this study showed that the “warm-up training program” is a suitable and effective tool for improving soccer-specific physical performance characteristics of junior soccer players. The high compliance rate in this study suggests that the program is easy to implement and can be incorporated in a regular soccer practice.

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