

The effects of small-sided games versus traditional training on physical fitness and skills among Under-12 hockey players

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Abstract

Background and Study Aim Despite many evidences showed the effectiveness of small sided games (SSG) to be included in sport training programs, majority of the study was done in soccer, while is very limited in hockey. The purpose of this study was to determine and compare the effects of small sided games and traditional training on physical fitness components (cardiovascular endurance, power, speed) and skills (dribbling, hitting, passing) among Under-12 hockey players.

Material and Methods A total of 36 primary schools' male students aged below 12 that represent their district were randomly divided into three groups; i) 3x3, ii) 4x4 and iii) traditional training (TT). The yo-yo test (cardiovascular endurance), standing long jump test (power) and 30m sprint test (speed) were conducted to measure level of physical fitness performance while the skills of the players was tested based on the skills of dribbling, hitting and passing. Pre- and post-tests were conducted on all fitness and skill level before and after 8 week intervention period. Mixed between within analysis of variances (ANOVA) was used to analyze the differences in physical fitness and skills performance between and within the three groups.

Results The results of this study showed all groups managed to improve their physical fitness and skills in the post test. However, the 3x3 and 4x4 SSG have better improvement compared to TT in physical fitness while no significant differences were found in skills tests.

Conclusions In conclusion, SSG interventions were found to be more effective in improving physical fitness but not in terms of skills. Coaches are encouraging to implement SSG in their training program in order to improve both physical and skills among hockey players.

Keywords: physical conditioning, training program, sport-specific training, youth sport, performance

Introduction

Small sided games (SSG) are a training method that modifies playing area size dimensions, rules and players formations to compete like a real situation (actual match) [1, 2, 3, 4]. Years by years, study on the effectiveness of SSG keep getting attention because it was shown to improve athletes' physical fitness, technical and tactical skills simultaneously to meet the demands of the game [3, 4, 5, 6]. In order to investigate the effectiveness of SSG training, numerous comparison studies have been conducted between SSG training with other training methods. It was also found in study by Pekas et al. [7] which showed SSG training significantly improved power and passing skill accuracy among volleyball player compared to the instructional training (traditional) method. Other than that, study by Amani-Shalamzari [6] showed both SSG and Generic Fitness Training

(GFT) increase physical fitness and only SSG increase technical performance. The most frequent training method that have been compared with SSG was high intensity interval training (HIIT), which usually showed similar effect on the improvement in cardiovascular endurance performance by both type of training [8, 9, 10, 11].

SSG is one of the training methods that often being practiced in team sport such as soccer and has proven its effectiveness in various aspects of physical fitness and technical performance [12, 13, 14]. Hockey is a team sport involves tactical skills such as attacking and defending. In addition, there are various type of technical skills in hockey such as dribbling, hitting, and passing skills. This game situation requires the player to have not only good technical skills but also having optimum physical fitness level such as cardiovascular endurance, speed, agility and power to meet the competition demands [15]. However, lack of studies related to SSG training conducted in hockey especially among children, thus little evidence was available regarding

appropriate SSG training format for young hockey player to ensure it can reach the usual desired match intensity.

However, conducting SSG training program should have several aspects to be considered. Among them is the size or format of the SSG. In hockey, the SSG can be played by having at least 2x2 to promote skills improvement such as passing. The more number of players would promote coordination and teamwork. However, previous studies in soccer have shown that 3x3 formation is better to enhance cardiovascular endurance. Thus, a coach should consider how the SSG training can be used to promote both skills and physical fitness in order to save time while optimizing the benefit. The effects of the formation of SSG in hockey is rare, thus, a study is needed as a reference to the coaches.

Therefore, the purpose of this study was to determine the effect of 8 weeks 3x3 and 4x4 small sided games training on physical fitness and specific hockey skill performance among male hockey player under 12 years old.

Materials and Methods

Participants

A total of 36 male hockey players under 12 years old was involved in this study. All participants were divided into three groups, which consisted of 3vs3, 4vs4 and traditional training (TT) groups. Both the 3vs3 and 4vs4 intervention groups received small sided games (SSG) training for eight weeks, while the control group underwent normal training as usual. Pre- and post-tests of physical fitness and skills were performed on all three groups. Participants were free from any injuries and participation consent has been signed by their parents. This research has been approved by the Sultan Idris Education University Research Ethical Committee.

Research Design

Physical fitness measured in this study consisted of cardiovascular endurance, power and speed. Yo-yo test was performed to measure cardiovascular endurance. Cones were used to mark out two lines 20m apart. To start the test, participants were instructed to place their foot behind one of the lines and begin running to another line when the beep sound start. The “beeps” tempo quickens after every minute. Participants must continuously run between the two lines following “beeps” tempo and they will be stopped if did not arrive at the lines two times in a row.

Standing long jump test was performed to measure power. For this test, participant was asked to stand and place their feet behind the line marked. Participant then ready by swinging the arms and bending the knees to jump horizontally as far as their can and landing with two foot. Each participant was given three attempts, the furthest distance counted

as performance.

Lastly, 30m sprint test was performed to measure speed. For this test, cones were placed between the starting and finishing line 30 m apart. Participant then sprint as fast as possible from starting line to finishing line. The stopwatch started when the participant starts the run and stopped when the participant finished the run. Each participant was given three attempts, the fastest time being recorded as performance.

Beside physical fitness test, this study also measured specific hockey skill consisting of dribbling, hitting and passing. For dribbling test, the cones were placed in a straight line of 10 meters apart. Participant were instructed to dribble the ball by using hockey stick through the cone slalom. Time was taken from start of dribbling to the end when the ball crosses the last cone.

To perform hitting skill test, participant stand behind the line marked, then hit the ball by using hockey stick to the goal. Performance was counted based on the number of balls successfully put into the goal.

Lastly, for passing skill test, participant required to pass the ball by using hockey stick into several target that have been set around them.

Statistical analysis

Descriptive statistic was used to obtain mean and standard deviation. A 3x2 mixed design ANOVA was used to determine the effect of small sided game training between intervention groups (3vs3, 4vs4) and control group during pre and post-test on physical fitness and skills performance. P-value of 0.05 was set as significant value. All statistical analysis was performed using Statistical Package for Social Science (SPSS) Version 23.

Results

Participants characteristics

Table 1 showed the mean and standard deviation of participant physical characteristics consisting age, height and body mass.

Table 1. Mean and standard deviation of participant physical characteristics.

Hockey player (N=36)	Mean± Standard Deviation
Age (years)	11.12 ± 0.72
Height (cm)	155.58 ± 2.68
Body mass (kg)	45.25 ± 2.59

Result of the mixed between within ANOVA indicated that there was significant interaction ($p < 0.05$) for cardiovascular endurance $F(2,33) = 7.836$, $p = .002$, $\eta_p^2 = .322$ between test and group. Table 2 showed the mean and standard deviation for physical fitness component during pre and post-test between group. As showed in table 2, no significant

difference during pre-test for all group. However, yo-yo test performance that was converted to vo2max value in group 3vs3 ($p=.013$) and 4vs4 ($p=.022$) were significantly better compared to traditional training (TT) in post-test. No significant difference was showed between group 3vs3 and 4vs4.

There was significant interaction for power $F(2,33)=10.176$, $p=.000$, $\eta_p^2=.381$ between test and group. No significant difference during pre-test for all group. However, as showed in table 2, standing long jump performance on group 3vs3 ($p=.033$) and 4vs4 ($p=.014$) were significantly greater compared to traditional training (TT) in post-test. No significant difference was showed between group 3vs3 and 4vs4.

As the other 2 parameters, there was significant interaction for speed $F(2,33)=4.092$, $p=.026$, $\eta_p^2=.199$ between test and group. No significant difference during pre-test for all group. However, 30m shuttle run test performance on group 3vs3 ($p=.022$) and 4vs4 ($p=.009$) were significantly greater compared to control group in post-test. No significant difference was showed between group 3vs3 and 4vs4 (table 2).

Table 3 showed the mean and standard deviation for skills performance during pre and post-test between group. Result of the mixed between within ANOVA in table 3 indicated there was significant differences of pre- and post-test in each groups ($p<0.05$). However, no significant differences were found between all the groups in the pre- and post-tests ($p>0.05$).

Discussion

The results of this study indicated that all kind of training whether adopting SSG or traditional methods successfully improved the physical fitness and hockey specific skill performance of under 12 hockey players. However, using SSG methods were found to be more effective on the physical fitness components.

Previously, Asci [12] have compared various player formations in soccer (3vs3, 4vs4, 5vs5, 7vs7 and 9vs9) and have found 3vs3 formations significantly increase heart rate result (HR and % Hr_{max}) compared to other formation which indicates the occurrence of an increase in intensity. According to Asci [12], reducing number of player gave opportunity for players to play at sufficient high intensity zones during SSG training, thus allows players to meet the demands of the actual match. This cardiovascular endurance performance enhancement may also be associated with an increase in maximum oxygen uptake as found in study by Delextrat and Martinez [16] that showed 6 week of SSG training significantly improve Vo_2max capacity. While, Delextrat et al. [17] explained that adaptation results from high intensity training such as SSG with 3vs3 formation and 4vs4 was capable to speed up the recovery of PCr storage associated with the process of reoxygenation. A faster rate of muscle reoxygenation in recovery from exercise can result better muscle aerobic function due to the increasing of muscle oxidation capacity and increasing of blood

Table 2. Mean and standard deviation for physical fitness component during pre and post-test between group.

Physical fitness component	Test	3vs3	4vs4	TT
Cardiovascular: vo2max (mL/kg/min)	Pre	39.08±2.42	38.83±2.20	38.75±2.36
	Post	42.15±1.00 ^c	42.33±1.96 ^c	40.08±2.50 ^{a,b}
Power: vertical jump (cm)	Pre	31.40±2.16	32.08 ±1.16	31.98±2.67
	Post	36.55±0.16 ^c	36.77±0.19 ^c	33.55±0.15 ^{a,b}
Speed (s): 30 m sprint (s)	Pre	5.93±4.92	5.88±.515	5.99±.515
	Post	5.45±.622 ^c	5.40±.652 ^c	5.72±.515 ^{a,b}

Note: a= significantly difference from 3vs3 group, $p < 0.05$; b= significantly difference from 4vs4 group, $p < 0.05$; c= significantly difference from TT, $p < 0.05$

Table 3. Mean and standard deviation for skills performance during pre and post-test between group.

Skills	Test	3vs3	4vs4	TT
Dribbling (s)	Pre	15.42±1.44	15.17±1.44	15.58± 1.88
	Post	14.37±1.30	14.25±1.12	14.23±1.19
Hitting (n)	Pre	6.25±.965	6.08±1.08	6.33±1.07
	Post	7.38±1.21	7.25±0.96	7.40±0.90
Passing (n)	Pre	15.01±2.74	15.08±2.78	15.21±2.72
	Post	16.43±1.31	16.50±1.24	16.75±2.08

flow to the muscles simultaneously that allows player to play longer in the game.

Other than that, power performance also improved in this study. This result was in line with the studies by Karahan [18] and Iacono et al. [19] that have compared the effect of SSG training with skill based training (SBT) and repeated shuffle sprint (RSS) on power performance. According to Karahan [18], SSG training was relevant and can be used to improved power performance due to the reduction of players in the SSG game formation causes players have to do acceleration more often, on a regular basis indirectly builds up explosive of leg strength. In addition, result of 8 week SSG training in this study sufficient to improve power performance, in contrast to the study by Rodríguez-Fernández et al. [20], and Paul et al. [21] which showed that SSG training for 4 and 5 weeks was not sufficient to improve power performance. It proved that power development can be influenced by duration of intervention training.

Moreover, speed performance enhancement in this study was similar to the previous studies that were conducted on the comparison between SSG training with RSS and HIIT [8, 19] which showed improvement in performance in the SSG group was similar to RSS and HIIT training. Successful speed performance improvement through SSG training can be caused by repetitive sprint movement performed by players due to the small number of players in training and increasing in the explosive force of the leg muscles, thus increase motor movement unit such as efficiency of lengthening and shortening muscle cycle.

Despite the success of SSG training in improving physical fitness greater than TT, skill performances were shown not to be differences between groups. Timmerman et al. [15] found SSG formation 3vs3 significantly increase dribbling skills compare to 6vs6 and control group among hockey players. Clemente and Rocha [22] in their study conducted effects of SSG formation 2vs2, 3vs3 and 4vs4 on handball players showed increase in dribbling performance. They argued the improvement is contributed by repetitive movement performed which is, the less number of players the larger playing area and the more dribbling movements need to be performed by players to attack and defence.

No significant differences between groups were also shown in hitting skill. Study by Nathan [23] compared the effects of SSG on high skilled and low

skilled players and the results showed hitting score among high skill player was higher compared to low skill player. Thus, it can be concluded that, the magnitude of improvement is affected by maturity and level of performance, in which this study only employed Under-12 years old hockey players.

Lastly, no significant differences between all groups were also found in passing skill. All groups were shown to have significant improvement in the passing skill in the post-test, in line with Eniseler et al. [13] that conducted the effects of SSG on passing skill among soccer players. The non-significant differences suggested that in terms of skill performance, any kind of training should be effective as this is the stage of learning and improving the skills among the Under-12 years old participants.

Conclusions

In conclusion, 8 weeks SSG training was found to be more effective in improving physical fitness compared to TT. The reduction in the number of players by using SSG formations 3vs3 and 4vs4 in this study compared to normal training resulted in increasing the game intensity allowing for the adaptation of aerobic capacity among players, thus enhance cardiovascular endurance performance. Other than that, this 3vs3 and 4vs4 SSG formation also causes players have to do repetitive high-intensity runs movement more frequently, indirectly develop their explosive of the leg muscle production that can improve power performance as well as speed performance. Despite the skill performance were shown to be significantly improved in all groups, there were no significant differences found when comparing between groups. This condition can be contributed by the complexity of skill as participants of this study consisted of male hockey players under 12 years old who were still in the developmental stage and still did not reach the level of cognitive and physical maturity to have greater magnitude of improvement.

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