

The impact of a boxing training program on physical fitness and technical performance effectiveness

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Abstract:

The aim of the recent study was to investigate the impact of boxing training intervention on general and specific physical fitness variables, as well as technical performance effectiveness (TPE) components. Thirty two male participants (aged = 22.84 ± 2.6 years) were recruited into a boxing ($n=17$) or control ($n=15$) groups. For eight weeks, both groups were carried out 3 workouts per week, comprising of sum 24 workouts of 120 minutes each (≈ 48 hours). General physical fitness variables (e.g. 30 m sprint test, 5×10m shuttle run test, 30 s sit ups, 10 s push-ups, standing broad jump, sit and reach test), specific physical fitness variables (e.g. lead hand punch 30s, rear hand punch 30s, total punches 30s, total punches in 1m) and TPE components (e.g. defensive skills effectiveness, offensive skills effectiveness, and total TPE) were investigated before and after post the training interventions. After eight weeks, significant differences were noted ($P < 0.05$) among the boxing and control groups within the post measurements, to the preferability of the boxing group. Boxing intervention was more efficient to develop physical fitness and TPE variables better than traditional intervention. Boxing coaches should utilize specific physical fitness exercises next to technical and tactical drills which comprise the vital components of effectual contest.

Key Words: Boxing, physical fitness, defensive skills, offensive skills

Introduction

Combat sports has been reported that might occupy affirmative impact on physical fitness (Cox, 1993; Woodward, 2009). The impact of combat sports exercise was examined in some researches on young people (Fukuda et al., 2013; Violan, Small, Zetaruk, & Micheli, 1997) adolescents (Fong & Ng, 2012; Melhim, 2001), older people (Brudnak, Dundero, & Van Hecke, 2002; Pons Van Dijk, Lensen, Leffers, Kingma, & Lodder, 2013) and disordered persons (Fong, Tsang, & Ng, 2012). The majority of these researches informed that combat sports practice included a considerable development in both physical fitness and motor competence.

Boxing is a combat sport dates back to the ancient Egypt civilizations and is likely one of the oldest martial arts in the historiography of combating (Jordan & Herrera, 2008). Boxers wear official gloves, engaged at equal weight category, fighting in a timed contest (3 rounds x 3 min) with one minute interval between rounds (AIBA, 2017). At each round, judges evaluate scores of both boxers in accordance with the sum of clean punches directed the target area of the opponent with the knuckle part of the glove (Osman, 1993). Performing attacks and defenses using from variety of movements and positions that incorporate offensive and defensive actions as well as counter-attack movements necessitate a high extent of physical capacity (Davis, Wittekind, & Beneke, 2013; EL-Ashker, 2011).

Boxing training program comprises a variety of basic and complex skills (El Ashker, 2012), plus sparring drills (Thomson & Lamb, 2016; Thomson & Lamb, 2017). Recent research (Jackson, Edginton-Bigelow, Cooper, & Merriman, 2012), inspected a significant effect of utilizing a sport specific training program on selected physical fitness component (i.e., balance) with mobility impairments. To date, no researches investigated the effect of boxing training program on general or specific physical fitness components plus technical performance effectiveness among adults boxers neither in Egypt nor in the Eastern Mediterranean region. In reference to the hypothetical deliberation recommended, we hypothesized that boxing training program would be linked positively with physical fitness and technical performance effectiveness. Consequently, the aim of the recent study is to examine the impact of boxing training program intervention on general and specific physical fitness components as well as technical performance effectiveness.

Materials and methods

Subjects

Thirty two male participants from Dakahlia (*Egyptian province lying northeast of Cairo*) sports clubs who participated three times at least in national boxing contests, were recruited to contribute in the current study. Participants were randomly apportioned to boxing ($n=17$) or control ($n=15$) groups. Of the preliminary commencing cohort (see Figure 1), participants accomplished all study procedures. The boxing group characteristics were (age: 22.6 ± 1.7 years, body weight: 75.3 ± 8.2 Kg, stature: 174.7 ± 9.4 cm, body mass index: 20.4 ± 3.8 kg/m²) whereas the control group characteristics were (age: 23.1 ± 2.1 years, body weight: 77.2 ± 9.1 Kg, stature: 173.9 ± 10.2 cm, body mass index: 21.2 ± 2.6 kg/m²). Eligibility criteria predetermined that participants were involved at least in 2 to 3 training workouts per week, non-smokers, and were qualified to participate in the interventions according to the study plan, based on a written medical questionnaires completed earlier to the study.

Exclusion criteria were as follows: present or past severe illness, recent physical injury, performing other boxing training workouts per week, attend \square 90% training adherence, or absence from post-test. All participants were knowledgeable about the study objectives, risks and benefits, that contribution was voluntary, as well as they possibly retreat from the study. Local institutional review board reviewed and approved the study.

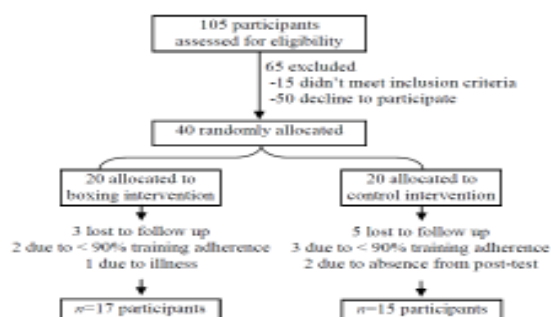


Figure 1. Participant recruitment and contribution in the training interventions.

Procedures

All Participants were examined at baseline (pre the training programs interventions) and after eight weeks (post the training program interventions). All were familiar with measurements procedures two weeks prior to the beginning of the measurements. All measurements were executed at the similar time of day to decrease the impact of diurnal differences on performance (Rae, Stephenson, & Roden, 2015). Participants were informed not to receive any medications, caffeine, or implement any vigorous activity in the 24 hours prior to assessing measurements. Six qualified research assistants and three neutral boxing referees examined participants' physical fitness and technical performance effectiveness variables.

Training program interventions

Both training program interventions were carried out 3 times per week lasting for 8 weeks, comprising of sum 24 workouts of 120 minutes each (\approx 48 hours). Within training workouts, participants informed to keep the daily dietary as consistent as possible. Training programme' intensity was considered using Karvonen's method [Target Pulse Rate = [(utmost pulse rate – resting pulse rate) \times %Intensity] + resting pulse rate] (Diaz-Buschmann, Jaureguizar, Calero, & Aquino, 2014) ; whereas utmost pulse rate was estimated as deduct participant's age from 220.

Boxing training program intervention

Boxing intervention program were divided into three progressive stages; 1st stage was intended to general physical fitness development in addition to affirm building up essential and basic technical skills; 2nd stage planned to expand specific physical fitness variables as well as improve complex technical skills together with contest practice; 3rd stage was projected to regulate and correct technical performance, practice competition plus highlighting tactical guidance. Workouts consist of boxing specific activities [i.e., core strengthening exercises - shadow boxing - simulate quick, counter with a snap back and twist include - skipping rope-medicine ball rotational throws – speed footwork - cardio boxing –boxing bags – working with dancing ball – speed ball – combating with one hand or two handed – combating with tall, short, right, or opponent left handed opponent- boxing combinations –conditioned boxing – and free boxing].

Control training program intervention

Control group executed only general physical exercises activities consisted of a number of recreational and physical fitness practice near to school's classes, intended to be more comprehensive and active. The workouts involved of general sport and physical activities [i.e., basketball – volleyball – football – handball - table tennis – athletics - core conditioning – running - basic motor skills - perform offensive or defensive skills individually – closed boxing 'both boxers are familiar with what is going to happen'].

Test procedures

10 \times 5 m shuttle run test

This test was utilized to measure speed and agility. Participants were instructed to sprint as quick as possible between two markers 5 m apart 10 times (Council of Europe, 1988).

Sit and reach test

Each participant was seated on the floor with legs stretched out straight ahead with knees locked, pressed flat to the floor, and fully extended. Participants were instructed to touch forward along the scale line as far as possible, whereas palms lining downwards, and hands side by side. Score is considered to the nearby centimeter as the length attained by the hand (Council of Europe, 1988).

30 m sprint test

Subsequently a 10-min standardized warm-up with lower body stretching routine, from a standing start position on a football field, participants instructed to accomplish two 30-m sprints with 60 s recovery intervals between sprints. Best sprint time was considered for data analysis (Chu, 1996).

10 s Push-Up Test

The participants informed to push up off the floor as quick as possible and straighten their arms without bending the elbow joints, while maintaining back and legs straight. During the test, the back must be sustained continuing in the equivalent line without any deviating between head and toes. Then, participants should lower the body by the arms till elbow angles reach 90° with upper arms are parallel to the floor. Test movement is repeated as quick as possible (Hassanein, 1987).

Sit-ups in 30 seconds

Starting from sitting on a flat ground with the knees bent $\approx 90^\circ$ of flexion, along with keeping the feet held down by a research assistant and located ≈ 10 cm apart on the ground. Hands were fastened behind the neck region. After hearing the beep sound, participant raise the chest with the upper body is upright, subsequently go back to the ground and return this movement as quick as possible (Council of Europe, 1988; Ryman Augustsson et al., 2009).

Standing broad jump

The participant stood with feet somewhat apart behind a marked line, with swinging the arms along with bending knees to supply forward drive then take-off strongly to jump forward and landing on both feet. Measurement is considered from take-off point to the closest point of touch on the ground when landing (back of the heels). Test was performed 2 times, and the highest record was accredited (Castro-Piñero et al., 2009; Council of Europe, 1988).

Technical performance effectiveness (TPE)

All subjects were video analyzed through 3 x 3 min duration boxing match. Three authentic neutral boxing judges, who weren't aware of the study objectives, evaluate and referee the defensive, offensive, and total TPE based on Khedr's (1996) method as below.

Defensive Skills Effectiveness (n/N)

Participants defensive performance was evaluated by dividing the sum of correct accomplished participant defense (n) 'whether performed by hand, foot, or trunk' by the total number of attacks demonstrated by the opponent in attacking boxing tactics (N) throughout the contest (Khedr, 1996).

Offensive Skills Effectiveness (n1/N1)

Evaluating the offensive performance was derived from dividing the sum of successful attacking skills ($n1$) by the whole attack endeavor ($N1$) performed through the contest (Khedr, 1996).

Total Technical Performance Effectiveness (TPE) = (n/N + n1/N1) / m

Having both offensive and defensive skills effectiveness amounts, easily we can get the total TPE (M) by adding the amount of both defensive and offensive skills and dividing by the amount of played rounds (m) (Khedr, 1996).

Data Analysis

The statistical analysis was processed utilizing the SPSS application package V 16.0 (SPSS Inc, Chicago, IL, USA). The means and standard deviations were computed for all the parameters. Consequently, paired t-tests were utilized to evaluate the differentiations between the two sets of observations (*pre and post*) within groups. Student's t-test were utilized to conclude statistical differences between groups. P value was set at 5% for all statistical analyses.

Results

For control group measurements (pre and post tests) weren't equivalent following to 8 weeks. Results presented significant enhancements for post tests within tested components. Table 1 shows the positive significant differentiation in the post tests than pre tests. There were relative improvement ratios for the general physical fitness variables (e.g. 30 m sprint test, 5x10m shuttle run test, 30 s sit ups, 10 s push-ups, and standing broad jump), post tests were significantly ($p < 0.05$) higher comparable to pre tests, ranged 4.94%, 2.34%, 13.04%, 6.64%, and 7.33% correspondingly. Surprisingly we found a negative changes in sit and reach test, which decreased to -10.72%. With regard to specific physical fitness variables in post tests, (e.g. lead hand punch 30s, rear hand punch 30s, total punches 30s, total punches in 1m) were significantly ($p < 0.05$) higher than pre tests by 8.13%, 6.56%, 4.27%, and 5.85% respectively. TPE variables, (e.g. defensive skills effectiveness,

offensive skills effectiveness, and total TPE) were significantly ($p < 0.05$) advanced relative improvements in post tests comparable to pre tests by 4.17%, 30.00%, and 18.60% respectively.

Table 1. General and specific physical fitness, and TPE of control group after 8 weeks.

Parameter	Pre: Mean(s)	Post: Mean(s)	Change (95% CL)	P-value
<i>General physical fitness</i>				
30 m sprint test (s)	4.67±0.16	4.45±0.26	-0.22 (-0.38 / -0.06)	<0.01
5×10m shuttle run test (s)	11.80±0.41	11.53±0.41	-0.27 (-0.37 / -0.17)	<0.00
30 s sit ups (reps)	33.07±3.90	36.73±2.58	3.66 (2.37 / 4.97)	<0.00
10 s push-ups (reps)	17.07±1.71	18.07±2.09	1.01 (0.16 / 1.84)	<0.02
Standing broad jump (cm)	229.00±7.32	244.33±8.63	15.33 (12.05 / 18.62)	<0.00
Sit and reach test (cm)	15.76±1.59	14.07±1.62	1.09 (-1.01 / -0.19)	<0.00
<i>Specific physical fitness</i>				
Lead hand punch 30s (reps)	61.09±4.13	65.65±4.19	4.56 (2.31 / 3.22)	<0.00
Rear hand punch 30s (reps)	57.86±3.48	61.33±3.44	3.47 (1.90 / 2.64)	<0.00
Total punches 30s (reps)	102.53±4.55	105.33±4.65	2.8 (3.08 / 4.15)	<0.00
Total punches in 1m (reps)	127.11±5.44	132.67±5.69	5.56 (4.77 / 3.55)	<0.00
<i>TPE components</i>				
Defensive skills effectiveness (%)	0.24±0.05	0.25±0.03	0.01 (0.03 / 0.09)	<0.00
Offensive skills effectiveness (%)	0.20±0.05	0.26±0.03	0.06 (0.04 / 0.06)	<0.00
Total TPE (%)	0.43±0.09	0.51±0.06	0.08 (0.05 / 0.07)	<0.00

TPE: technical performance effectiveness. Change; post mean minus pre mean. ns: not significant.

Boxing group measurements (pre and post tests) weren't equal subsequent to 8 weeks of boxing training program intervention. Post tests presented significant enhancements within all variables. Table 2 signifies the significant differences, with more constructive values in the post test. Regarding relative improvements between pre and post tests, there were improvement ratio for the general physical fitness variables (e.g. 30 m sprint test, 5×10m shuttle run test, 30 s sit ups, 10 s push-ups, standing broad jump, sit and reach test) were significantly ($p < 0.05$) advanced in post tests than pre tests by 9.47%, 5.82%, 26.09%, 19.13%, 12.62%, and 29.00% correspondingly. As well as specific physical fitness variables in post tests, (e.g. lead hand punch 30s, rear hand punch 30s, total punches 30s, total punches in 1m) were significantly ($p < 0.05$) higher than pre tests by 19.39%, 15.27%, 14.64% and 24.40% respectively. Furthermore, TPE variables, (e.g. defensive skills effectiveness, offensive skills effectiveness, and total TPE) were significantly ($p < 0.05$) higher relative improvements in post tests than pre test by 39.13%, 73.68%, and 54.76% respectively.

Table 2. General and specific physical fitness, and TPE of boxing group after 8 weeks.

Parameter	Pre: Mean(s)	post: Mean(s)	Change (95% CL)	P-value
<i>General physical fitness</i>				
30 m sprint test (s)	4.74 ± 0.16	4.33 ± 0.26	-0.40 (0.15 / 0.20)	<0.0001
5×10m shuttle run test (s)	11.64±0.46	11.00±0.45	-0.64 -0.73/ -0.57)	<0.0001
30 s sit ups (reps)	32.6±2.16	39.8±1.82	7.2 (6.11 / 8.29)	<0.0001
10 s push-ups (reps)	17.01±1.77	19.87±1.60	2.87 (2.28 / 3.45)	<0.0001
Standing broad jump (cm)	228.67±6.11	255.00±5.67	26.33 (22.49 / 30.17)	<0.0001
Sit and reach test (cm)	13.00±1.70	16.77±1.19	3.77 (2.94 / 4.60)	<0.0001
<i>Specific physical fitness</i>				
Lead hand punch 30s (reps)	59.93±3.63	70.58±2.17	10.65 (9.62 / 11.67)	<0.0001
Rear hand punch 30s (reps)	57.60±3.58	65.63±3.73	8.03 (7.47 / 8.59)	<0.0001
Total punches 30s (reps)	101.2±3.41	110.6±3.87	9.4 (8.36 / 10.44)	<0.0001
Total punches in 1m (reps)	125.73±3.03	148.6±5.45	22.87 (20.94 / 24.79)	<0.0001
<i>TPE components</i>				
Defensive skills effectiveness (%)	0.23±0.05	0.32±0.08	0.09 (0.06 / 0.13)	<0.0001
Offensive skills effectiveness (%)	0.19±0.05	0.33±0.08	0.14 (-0.53 / -0.38)	<0.0001
Total TPE (%)	0.42±0.09	0.65±0.14	0.23 (0.09 / 0.12)	<0.0001

TPE: technical performance effectiveness. Change; post mean minus pre mean.

Both control and boxing groups weren't equal subsequent to 8 weeks (post finishing their relevant training program interventions). Boxing group players presented significant enhancements through all variables than controls. Table 3 represents the significant enhancements, with more positive values in the boxing group. With reference to relative improvements between the two groups, we found that improvement ratio for the general physical fitness variables (e.g. 30 m sprint test, 5×10m shuttle run test, 30 s sit ups, 10 s push-ups, standing broad jump, sit and reach test) were significantly ($p < 0.05$) higher in boxing groups than controls ranged 2.77%, 1.09%, 0.34%, 11.20%, 4.76%, and 19.19% respectively. In addition to specific physical fitness variables in boxing groups, (e.g. lead hand punch 30s, rear hand punch 30s, total punches 30s, total punches in

1m) weresignificantly ($p < 0.05$) elevated than controls by 8.13%, 7.63%, 7.71%, and 15.82% respectively. Moreover, in connection with TPE variables, (e.g. defensive skills effectiveness, offensive skills effectiveness, and total TPE) there were significantly ($p < 0.05$) higher relative improvements in boxing groups than controls by 28.00%, 26.92%, and 27.45% respectively.

Table 3. General and specific physical fitness, and TPE of control and boxing groups after 8 weeks.

Parameter	Control: Mean(s)	Boxing: Mean(s)	Change (95% CL)	P-value
<i>General physical fitness</i>				
30 m sprint test (s)	4.45±0.26	4.33 ±0.26	-0.12 (0.17/ 0.24)	< 0.003
5×10m shuttle run test (s)	11.53±0.41	11.00±0.45	-0.53 (-0.86 / -0.21)	< 0.002
30 s sit ups (reps)	36.73±2.58	39.8±1.82	3.07 (1.40 / 4.74)	< 0.001
10 s push-ups (reps)	18.07±2.09	19.87±1.60	1.80 (0.41 / 3.19)	< 0.013
Standing broad jump (cm)	244.33±8.63	255.00±5.67	10.67 (5.20 / 16.13)	< 0.001
Sit and reach test (cm)	14.07±1.62	16.77±1.19	2.70 (1.64 / 3.77)	< 0.001
<i>Specific physical fitness</i>				
Lead hand punch 30s (reps)	65.65±4.19	70.58±2.17	4.93 (2.43 / 7.42)	< 0.001
Rear hand punch 30s (reps)	61.33±3.44	65.63±3.73	4.30 (1.61 / 6.98)	< 0.003
Total punches 30s (reps)	105.33±4.65	110.6±3.87	5.27 (2.07 / 8.47)	< 0.002
Total punches in 1m (reps)	132.67±5.69	148.6±5.45	15.93 (11.77 / 20.10)	< 0.000
<i>TPE components</i>				
Defensive skills effectiveness (%)	0.25±0.03	0.32±0.08	0.07 (0.02 / 0.11)	< 0.004
Offensive skills effectiveness (%)	0.26±0.03	0.33±0.08	0.07 (0.02 / 0.12)	< 0.007
Total TPE (%)	0.51±0.06	0.65±0.14	0.13 (0.05 / 0.22)	< 0.003

TPE: technical performance effectiveness. Change; boxing mean minus control mean.

Discussion

The results of the recent study verified that boxing training program intervention significantly included developments in general physical fitness (i.e., 30 m sprint test, 5×10m shuttle run test, 30 s sit ups, 10 s push-ups, standing broad jump, and sit and reach test), specific physical fitness (i.e., lead hand punch in 30 seconds, rear hand punch in 30 seconds, total punches in 30 seconds, and total punches in 1 minute) as well as improvements in TPE (defensive skills effectiveness, offensive skills effectiveness, total TPE) when comparing to pre-tests and controls values. A small number of studies examined physical fitness variables and TPE components following to boxing training intervention in male boxers whether in Egypt or in the Middle East region. It was hard to find study inspected the impact of boxing activities by its training characteristics on physical fitness. The entanglement is that we encountered scarcely references with which we use in comparing the recent results.

For the general physical fitness (e.g. 30 m sprint test, 5×10m shuttle run test), attained significant enhancement might be attributed to specific actions in boxing which comprises frequent quick paces and movements that are distinguished by ability to move quickly (Arseneau, Mekary, & Leger, 2011). Boxing has particular training programs that comprises intensive and attentive drills which are perfect way to develop speed (Oliver, 2007). Moreover, we can declare that boxing drills may assist in developing physical fitness, also it can be utilized in determining athletic form in boxing. Then, using boxing equipment (e.g. boxing bag, double-end bag, or speed ball) is physically challenging, furthermore it does advance and achieve the components of physical fitness.

In the same way, muscular strength (i.e., 30 s sit ups, 10 s push-ups, and standing broad jump) increased significantly following the training program. Most likely, adjusts in muscular strength might be clarified by the reality that boxing training program variables (i.e., volume, intensity and density) might lead to affect the nervous system positively (Patten, Kamen, & Rowland, 2001). Additionally, all body muscles in the performed tests (upper, trunk, lower body regions) were been developed significantly, and we can illustrate that by the cause of specificity of boxing training programs, which boxers depend on utilizing all body muscles in punching techniques and foot works (EL-Ashker, 2011).

The increasing in flexibility (sit and reach test) subsequent to the boxing training program might be a consequence of the boxing workouts. To achieve a desired technical and tactical characteristic in boxing, trainers should stress on enhancing physical fitness components. As boxing drills can be an excellent way to acquire victory, it requires flexible muscles (Ouergui et al., 2014). Therefore, boxing workouts might supply procedures for avoiding injuries by boosting the flexibility of whole body muscles especially the active muscles. Boxing training program was adequate to persuade growth in specific physical fitness components (i.e., lead hand punch in 30 seconds: rear hand punch in 30 seconds: total punches in 30 seconds: and total punches in 1 minute). The boxing group's training included specific combat skills that necessitate particular physical fitness variables with the intention of enhancing boxers' technical and tactical performance (EL-Ashker, 2011). This is compatible with different studies (Liukkonen, 2007; Zhongfan, Kimihiro, & Tooru, 2002), as drills employ conditional games prepare to imitate different situational features of the real game (e.g. free boxing training)

which are executed in a way that cannot be predicted, where skills are repeatedly altered (e.g. from defense to attack, and vice versa, from attack to defense), direct to excellent performance. Additionally, such boxing training also improve specific physical fitness components (EL-Ashker, 2011). Additionally, trainer and teammate drills in boxing is very important to stand great specific conditioning previous to a real opponent (Hatmaker & Werner, 2004).

Concerning to the constructive involvement of boxing training with TPE components (e.g. defensive skills effectiveness, offensive skills effectiveness, total TPE), may happened by the distinguished of its numerous components which are necessary for effectual boxing performance on the ring (e.g. concentration, tempo, timing, muscular strength, and accuracy) possible linked with the development of TPE.

Repeated established boxing training drills help boxers in selecting the appropriate defensive and offensive techniques quicker than players who were involving in traditional training programs (El Ashker, 2012). Consequently, our results are in agreement with previous suggestions (Hlustík, Solodkin, Noll, & Small, 2004; Krings et al., 2000) that executing technical skills that are >1 degree of freedom, plus possess integration of sequenced skills (e.g. offensive, defensive, and counterattacks) against opponent attempts, could advance the organizational tasks of the nerve center that control motive competences (Wulf & Shea, 2002) which make the motor tasks execute in good status. Chronological coordination is a key factor of boxing training requirements of different actions, and this may lead to improve a player's performance (Wulf, McNevin, & Shea, 2001)

Conclusion

Boxing necessitates general and specific physical fitness, quick adequate skills, in order to carry outfighting and maneuvering during the contest rounds. Since the strength of the punches begins from the angular actions of the foot, leg, hips, and trunk, physical fitness and conditioning are necessities of boxing workouts. Boxing trainers should utilize specific physical fitness exercises beside to technical and tactical drills which include the vital components of effectual contest. Away of boxing as a self defense sport, results propose that boxing training program appear to be an excellent method which be able to develop physical fitness. Accordingly, fitness trainers possibly will reflect on suggesting boxing drills to their customers as an advantageous type of practice to encourage physical fitness as well as rising the flexibility of body muscles which assist in avoiding injuries.

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