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Physiological Profile of Iranian Men National Taekwondo Team

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Abstract

Taekwondo athletes need high levels of physiological capabilities for optimal performance of movements - kicks and competing effectively in global and international fields. Current work aims at determining physiological profile of Iranian Men National Taekwondo Team. To this end, all Taekwondo athletes present in national tram camp in 2013 including 22 ones (with age average 21.39±2.14) were selected as the statistical sample. Measured physiological characteristics include aerobic power (gas analyzer), aerobic power at anaerobic threshold (Kank any test), anaerobic power with lactate (Argo jump test), trunk and lower extremity muscle endurance (sit and reach test, side jump), maximal lower extremity muscle strength (Sargent vertical jump), speed (40-yard sprint), reaction rate (visual reaction time), flexibility of trunk and lower extremity (trunk flexion test, forward and back), agility (4 × 9 sprint test) which were performed in four different Olympic weights. Findings indicate all weights had lowest performance in visual reaction time sub scale, while the best performance was observed in performance for aerobic power at anaerobic threshold which was related to third and fourth weights. In addition, in some indices such as trunk muscle endurance, maximal lower extremity muscle strength, and trunk flexibility similar performances are seen in all weights ($p \leq 0.05$).

Keywords: Aerobic power, anaerobic power, muscular endurance and strength, speed, flexibility, agility.

Introduction

Taekwondo (TKD) is a combat field originating from Korea. Such combat skills were trained aiming at to be used inpitched battles and etc. Taekwondo is currently the most popular combat field among all combat sports in terms of people involved in its training and exercising[1].

Taekwondo combats are done within 3 two-min rounds with one min rest between rounds, and in case equal result, combat is continued at fourth round. Each round is a combination of combat and rest which is repeated alternatively. Thus, Taekwondo combats can be regarded as a kind of alternative activity. The main sources of energy in such alternative activities are system phosphagen and anaerobic system (lactic acid system). These sources are discharged and reconstructed constantly within the activity. Maximum reconstruction is during 1 minute rest between rounds[2].

Taekwondo is among sports athletes of which represent high degree of aerobic and anaerobic power and thus it requires special fitness model. Speed, accuracy, coordination of activities, flexible body, quick understanding and implementing techniques are characteristics of Taekwondo[3].

Kazemi[4] reported martial artists need maximal muscle strength and endurance, because muscle structure of body extremity play important role due to implementing rapid and powerful movements which are done during combat repeatedly and move body weight. Of course, agility, coordination and balance capacities complement above capacities.

Most works on physiological characteristics such as works by Butios and Tasika[5], Bouhlel et al.[6], Markovic et al.[7] and Noorul et al.[8], described current status of physiological characteristics in athletes of national teams. Results of some works suggest significant difference in some physiological characteristics such as maximum, minimum and average power output and fatigue index in men compared to women[9]. Some studies addressed role of Taekwondo practices in development of physical capabilities and their findings indicated server and short term activities in Taekwondo mostly depend on anaerobic energy (lactic acid and phosphagen energy system). These energy systems provide necessary energy for kicking and defense. In addition, findings suggest Taekwondo practicesdo not have significant effect on resting heart rate and aerobic capacity of Taekwondo athletes[3,5,6,10,11,12]. Such authors as Bouhlel et al.[6] and Matsushigue et al.[11] found blood lactate concentrations rise significantly during and after Taekwondo matches in Taekwondo athletes at national level. Studies have shown dominant energy system for energy provision for muscles in Taekwondo is provided through anaerobic energy system[13]. Also, most energy sources in Taekwondo, which requires Short term fast actions and alternative movements and kicks, are provided through phosphagen system. In addition, maxima loxygen consumption (VO_{2max}) has been widely used by authors for investigating cardiorespiratory performance capacity of Taekwondo athletes. Studies onexperienced Taekwondo athletes

and elite Taekwondo athletes reported improved aerobic performance and maximal oxygen consumption[11]. Dronbic[14] obtained VO_{2max}in nonprofessional Taekwondo athletes as about 44 ml/kg/min. according to Dronbic, VO_{2max} is considerably higher than this value in elite Taekwondo athletes. Hong[15] stated successful Taekwondo athletes not only should have high metabolism, but they should have very good aerobic endurance.

Markovic[7] in investigation of Taekwondo athletes participating in national competitions showed successful Taekwondo athletes had higher speed, agility, explosive power and lactate threshold and lower heart rate compared to less-successful Taekwondo athletes. Also, height average in successful athletes was more than less-successful ones. According to Markovic, having such anthropometric and physiological characteristics are very important in female Taekwondo athletes. According to Gao and Markovic, successful Taekwondo athletes have lower fat percentage[7,16].

Some domestic authors draw profile of athletes in different sports fields such as wrestling, football, Taekwondo[17-19]. Results of these studies stress importance of physiological indices role in success of sports field. By promotion of Physical Education and Sports Science, there are few people who deny key role of evaluation of athletes in improvement of their sports functioning so that coaches and designers of practices programs are aware of general readiness of the athletes and design their practices according to individual features. To this end, in Taekwondo it is also necessary to run specialized tests so that reliable practical framework is obtained by standardization and preparing related profile for evaluation of Taekwondo national athletes so that achievement of the best performance is obtained.

Due to utilization of above mentioned factors, Taekwondo combat field needs athletes with special conditions and capabilities. Thus, understanding these capabilities through investigation of anatomical, physiological and psychological status and specifying related profiles can help development of the efficiency considerably in Taekwondo athletes.

Therefore, coaches need to evaluate mentioned indices using appropriate and reliable tools, methods and software. It provides appropriate insight for coaches and authors of sport science for selecting talented people and the development of martial arts particularly Taekwondo. Also strengths and weaknesses and readiness of Taekwondo athletes can be specified by achieving these indices and coaches would be able to designing specific training, tailored to the needs of players.

In addition, having physiological profile for Men National Taekwondo Team causes that coaches and authorities of the federation become aware of characteristics and needs of athletes and such awareness and understanding can be a good guide for providing and meeting their needs. Also, bodybuilding coaches emphasize on some factors in their exercise program which do not have high scores in Men National Taekwondo Team. Thus utilization of the current work helps better physical fitness for Iranian National Taekwondo Team.

The author aims at determining profile of psychological skills and physiological profile for Iranian Men National Taekwondo Team and answer following questions: A. To what extent male elite Taekwondo athletes are ready in terms of physical- motor fitness (psychological skills) and how is their profile? B. How are physiological skills of Iranian Men National Taekwondo Team compared with other countries?

Methodology

Current work is an applied descriptive and survey research. Statistical population includes all Iranian Men National Taekwondo Team in 2013 who were top athletes in 8 weights. Elite athletes include 8 top athletes or members of national teams in different age groups (adult, youth, and teens) or State Premier League teams. Adult and youth national team athletes and all taekwondo athletes present in the national team camp were considered as elite athletes. Thus, according to statistics by Taekwondo Federation, the number of participants in national team camp was 22 in 2013; therefore the whole population was selected as statistical sample.

It should be noted that respective tests were done at the end of preparation period of Iranian Men National Taekwondo Team for participation in World and Asian Championships 2013 when national team players were at top-level preparedness. Tests were recorded for 22 members of national team under supervision of expert from Olympic National Academy Centre for measuring physical capabilities in high precision and appropriate conditions.
In order to measure psychological characteristics of national team athletes, respiratory gas analysis system was used for evaluating aerobic and anaerobic power, Kankany test for evaluation of aerobic power at anaerobic threshold, Argo jump test for evaluating anaerobic power with lactic (first 30 s), sit and reach test and side jump with 10 cm obstacle for evaluating trunk and lower extremity muscle endurance, Sargent jump for evaluating maximal lower extremity muscle strength, 40-yard sprint for evaluating speed, visual reaction time test for evaluating reaction rate to visual stimuli, trunk flexion test, forward and back test for evaluating flexibility of trunk and lower extremity, and 4 × 9 sprint test for testing agility were used.

Descriptive statistics methods (mean and standard deviation), tables and diagrams were used for describing collected data. Also, considering difference in types of indices and measurement units for physiological characteristics, author turned test scores to z scores and calculated percentage so that necessary condition for comparison of scores in classified groups and weights is provided considering data homogenization. All statistical tests were analyzed at significance level ($p \leq 0.05$) using Excel and SPSS 18 software.

Results and Discussion

Table 1 gives demographic characteristics of Iranian Men National Taekwondo Team including age, height, weight, and sport background in Taekwondo.

The mean, standard deviation, Z scores and physiological characteristics of Men National Taekwondo Team in four weights are presented in table-2.

Profile of physiological characteristics of Iranian Men National Taekwondo Team in 4 different weights is compared in figure-1.

Table-1
Demographic characteristics of Iranian Men National Taekwondo Team

Index / Subjects		No.	mean and standard deviation of age (years)	mean and standard deviation of height (cm)	mean and standard deviation of weight (kg)	Mean and standard deviation of experience in the field of Taekwondo (years)
Men's taekwondo team	first weight	4	20.43 ±1.04	173.10±4.76	57.66±0.63	9.31±1.45
	second weight	4	21.18± 1.19	178.68±4.98	67.19±1.05	8.98 ±1.64
	third weight	6	22.17 ±1.12	183.72±3.77	78.76±1.38	10.22± 2.03
	Fourth weight	8	21.78 ±1.36	188.32±4.54	89.52±2.33	9.34± 2.1
	Total	22	21.39± 2.14	180.95±5.86	73.28±8.65	9.46±2.68

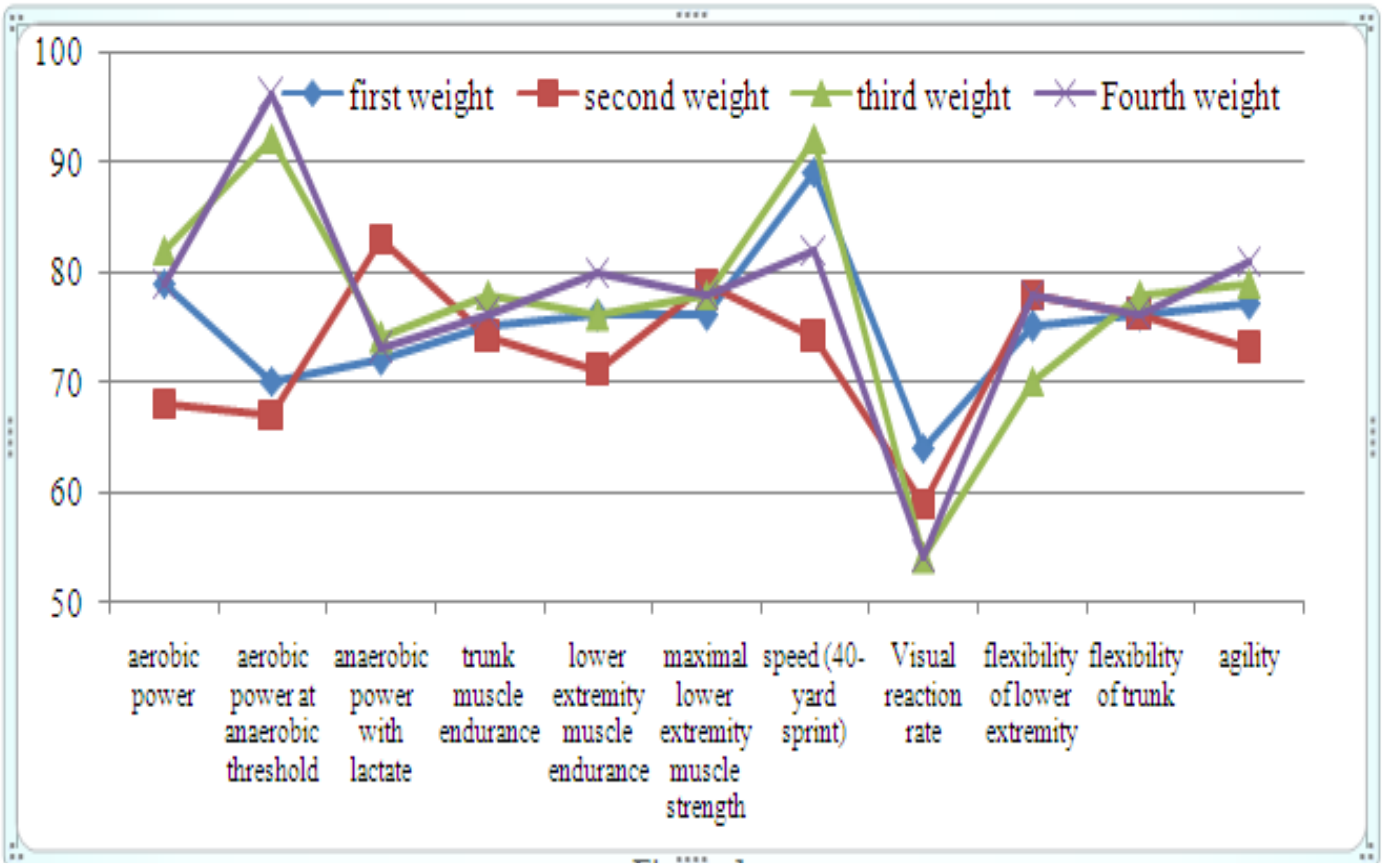

Figure-1
Comparison of physiological characteristics profile of Iranian Men National Taekwondo Team in 4 different weights (according to Z score)

Table-2
Mean, standard deviation, Z scores and physiological characteristics of Men National Taekwondo Team in various weights

Index	weights	Mean and SD	Z score	percentage
Aerobic power	1	37.38±3.25	0.81	79
	2	40.12±2.51	0.48	68
	3	49.73±2.93	0.93	82
	4	57.13±1.92	0.84	79
Aerobic power at anaerobic threshold	1	6.57±0.25	0.54	70
	2	5.69±0.37	0.44	67
	3	6.25±0.27	1.46	92
	4	6.43±0.09	1.85	96
Anaerobic power with lactate	1	4.72±0.23	0.61	72
	2	4.96±0.69	0.98	83
	3	4.72±0.41	0.65	74
	4	4.81±0.49	0.62	73
Trunk muscle endurance	1	54±1.41	0.7	75
	2	59.15±5.30	0.66	74
	3	56.44±7.38	0.8	78
	4	60±7.58	0.73	76
Lower extremity muscle endurance	1	127.5±2.12	0.71	76
	2	133.3±6.95	0.56	71
	3	135.55±11.68	0.72	76
	4	132.20±6.49	0.87	80
Maximal lower extremity muscle strength	1	57±0.7	0.71	76
	2	55.30±5.75	0.82	79
	3	59.22±6.01	0.78	78
	4	62.80±3.76	0.80	78
Speed (40-yard sprint)	1	4.72±0.02	1.25	89
	2	5.19±0.14	0.67	74
	3	5.09±0.19	1.41	92
	4	5.07±0.13	0.92	82
Visual reaction rate	1	0.42±0.91	0.38	64
	2	0.419±0.63	0.23	59
	3	0.431±0.73	0.11	54
	4	0.446±0.04	0.12	54
Flexibility of lower extremity	1	45±1.41	0.7	75
	2	39±4.59	0.79	78
	3	41±7.52	0.54	70
	4	42±5.77	0.78	78
Flexibility of trunk	1	65.5±3.53	0.71	76
	2	59.07±5.85	0.71	76
	3	54.77±4.17	0.79	78
	4	61.60±4.56	0.72	76
Agility	1	8.90±0.1	0.75	77
	2	8.37±0.32	0.63	73
	3	8.50±0.35	0.82	79
	4	8.26±0.23	0.91	81

As observed in figure 1, Iranian Men National Taekwondo Team had the lowest performance in visual reaction index in all weights, while the best performance is related to aerobic power in anaerobic threshold index for third and fourth weights. In addition, similar performance was observed in some indices such as trunk muscle endurance, maximal lower extremity muscle strength and trunk flexibility. Considering all physiological indices in weights 1-4, it is clear the highest difference from weight 1 to 4 is in aerobic power in anaerobic threshold index which is lowest in weight 2 and highest in weight 4.

Mean, standard deviation, Z scores and overall percentage of physiological characteristics for 22 Taekwondo athletes in national team in all classified weights are given in table 3.

As it is observed in table 3, Taekwondo athletes of national team gained better scores in aerobic power in anaerobic threshold index and 40-yard sprint index (85%) compared to other indices. Also, visual reaction rate index was lowest (58%) in them.

Discussion: Lack of physiological profile for elite national Taekwondo athletes in one hand, and lack of homogeneity in implementation and type of measurement tools and tests for physiological characteristics in few studies on the other hand, have led to lack of possibility for direct comparison of findings by the current work with domestic and foreign studies. However, findings in the current work were compared with other findings investigating physiological characteristics in elite Taekwondo athletes.

Table-3
Physiological indices for Taekwondo athletes in national team

Index	Mean and SD	Z score	Percentage
Aerobic power (mg/min/kg)	46.13±4.15	0.76	77
Aerobic power at anaerobic threshold (watt/kg)	6.30±0.56	1.07	85
Anaerobic power with lactate (watt/kg)	4.80±0.66	0.71	76
Trunk muscle endurance	57.39±1.87	0.72	76
Lower extremity muscle endurance	132.13±2.49	0.71	76
Maximal lower extremity muscle strength (cm)	58.58±1.32	0.77	77
Speed (40-yard sprint) (s)	5.01±0.18	1.06	85
Visual reaction rate (Ms)	0.426±1.71	0.21	58
Flexibility of lower extremity	41.75±1.98	0.7	75
Flexibility of trunk	60.23±3.84	0.73	76
agility	8.50±0.61	0.77	77

Aerobic power of Iranian Men National Taekwondo Team in weights 1-4 was 37.38, 40.12, 49.73, 57.13 and overall 46.13 mg/min/kg, receptively. Melhim studied effect of Taekwondo practice on aerobic and anaerobic power in young Taekwondo athletes and found it didn't show significant difference in resting heart rate and aerobic power of Taekwondo athletes. Although significant difference was observed in anaerobic power and capacity of Taekwondo athletes after practice (anaerobic power and anaerobic capacity increased by 28% and 61.5%, respectively), results of this work indicated Taekwondo practices lead to increased anaerobic power and anaerobic capacity, aerobic power would not be promoted[3]. Bouhlel et al. investigated heart rate and blood lactate responsein 8 top Taekwondo athletes. Their findings suggested there is high correlation between training condition and competition condition. They also showed Taekwondo athletes need high level of aerobic and anaerobic readiness. Maximal oxygen consumption of Taekwondo athletes in this work was 56.22±2.57 ml/min which is higher than aerobic power average in Iranian Taekwondo athletes and there is similarity in fourth weight regarding maximal oxygen consumption to findings by Bouhlel et al. [6]. However, findings by the current work are not comparable with findings by Bridge et al., Butios and Tasika, Heller et al.[10], Matsushigue et al., Pieteret al., and Toskovic et al., because maximal oxygen consumption was offered in four different weights in the current work. Age and weights are factors affecting VO_{2max}[5,10,20,21]. Physiological profile of elite Taekwondo athletes was determined in two studies by Toskovic et al.[21,22]. Also, Drobnic[14] obtained VO_{2max} of non-professionalTaekwondo athletes as about 44 ml/kg/min and stated VO_{2max} is considerably higher in elite Taekwondo athletes. Considering classification of aerobic power of Taekwondo athletes in national tem based on Olympic weights, it can be said weights 3 and 4 are higher than the average proposed by Drobnic, however it is not significant. Hong[15] stated successful Taekwondo athletes not only should have high metabolism, but also they should possess very good aerobic endurance. According to Jafari et al.[18] the main physiological index related to success of Taekwondo athletes is aerobic power.

In addition, most studies in successful and elite Taekwondo athletes reported improvement of aerobic performance and maximal oxygen consumption. Also, some studies reported contradictory results[3,8,23]. They reported average of maximal oxygen consumption in male Taekwondo athletes (44 ml/kg/min) is essentially lower than novice Taekwondo athletes participating in the study by Toskovic et al.[22]. Findings by this work showed constantly low VO_{2max} in studies on Taekwondo athletes, while higher VO_{2max} in Iranian Men National Taekwondo Team was reported in the current work. One reason for superiority of Iranian National Taekwondo Team in most weights in various weights may be due to their higher aerobic power.

Aerobic power in anaerobic threshold in Iranian National Taekwondo Team in weights 1-4 was 6.57, 5.96, 6.25, 6.43 and overall 6.30 watt/kg, respectively. Unfortunately there is not possibility for comparison due to lack of any norm and unavailability of information concerning this physiological characteristic.

Aerobic power with lactate in Iranian Men National Taekwondo Team in weights 1-4 was 4.72, 4.96, 4.72, 4.81 and overall 4.80 watt/kg. Lin,W-L[24] investigated aerobic capacity of elite Taekwondo athletes in Taiwan. Matsushigue et al.[11] observed server and short term activities in Taekwondo mostly depend on anaerobic energy (lactic acid and phosphagen energy system). These energy systems provide necessary energy for kicking and defense. Similarly, Melhim[3] studied effect of Taekwondo practice on aerobic and anaerobic power in young Taekwondo athletes and found there is significant difference anaerobic power and capacity of young Taekwondo athletes after practice, and results of this work indicated Taekwondo practices lead to increased anaerobic power and anaerobic capacity, but aerobic power would not be promoted. It should be noted the major energy sources in Taekwondo, which requires short term fast actions and alternative movements and kicks, are provided through phosphagen system[11]. Trunk muscle strength in male Taekwondo athletes of national team in weights 1-4 was 54, 59.15, 56.44, 60 and overall 57.39 per minutes, respectively. There is no norm concerning this physiological characteristic in Taekwondo field, but considering its comparison with the average obtained from Iranian elite badminton players (63 and 61.75 for men and women, respectively) it is clear that national team Taekwondo athletes are not in good condition in terms of trunk muscle strength. Thus, it seems necessary to paying more attention to this physiological factor in Taekwondo athletes by the coaches.

Lower extremity muscle strength in male Taekwondo athletes of Iranian national team in weights 1-4 was 127.50, 133.30, 135.55, 132.20, and overall 132.13 per min, respectively. Douris[25] studied balance, flexibility, quadriceps muscle strength and muscular strength in aged male and female martial artists and found measured indices average was higher than ordinary people in all age groups and genders. Kamyab et al. investigated leg muscle strength in Iranian elite badminton players with the same test and reported it as 142.80. it seems higher leg muscle strength in badminton players is due to rapid movements which should be done for passing the field. However, it is better to allocate more practice because of high use of legs in Taekwondo.

Maximal lower extremity muscle strength in Sargent jump test for Iranian Men National Taekwondo Team in weights 1-4 was 57, 55.30, 59.22, 62.80, and overall 58.58 cm, respectively. Some studies reported improvement of muscle strength under Taekwondo practices[10,21,26]. Heller et al.[10] found muscle mass is higher than normal value in people participating in Taekwondo practices. In addition, static muscle strength in bending the arm, opening the knee, taking the hand and explosive foot jumping in both genders is higher than normal. Some studies such as those by Cetin et al. , O'Donovan et al., and Pieter estimated relative strength of flexor muscles (hamstrings) and knee extensors (quadriceps) through co-movement test[27-29]. In comparison of above works' findings with the current work, higher lower extremity muscle strength in Iranian Taekwondo athletes is clear which is better in weight 4 compared to other weights. Thus, considering importance of this index in Taekwondo, it should be more considered in weights 1-3.

Speed of male Taekwondo athletes in Iranian national team in weights 1-4 for passing 40-yard distance was 5.21, 5.19, 5.09, 5.07, and overall 5.01 s, respectively. Since speed tests with different distances have been used in other studies, it is not comparable.

Visual reaction time in male Taekwondo athletes in Iranian national team for weights 1-4 was 0.420, 0.419, 0.431, 0.446, and overall 0.426 s, respectively. Many works have been done on reaction time and role of inheritance and practice. According to most authors, reaction time is mostly influenced by inheritance and less influenced by the practice. According to these authors, movement time is reduced by practice, but reaction time cannot be improved by practice. In contrast, Mokha and Rabbit and Banerji argue practice improves reaction time[30,31]. There is inverse relationship between reaction time and success of Taekwondo athletes[19]. Timely and powerful start of the striker technique prevents from success of opponent effective action and athletes should be able to react rapidly and powerfully to opponent attack[32].

Considering reaction time of Taekwondo athletes to opponent attacks and techniques plays significant role in giving or taking score, such relationship seems natural. However, Heller didn't find any significant relationship between reaction time and competitive performance of female Taekwondo athletes, but he reported significant relationship between reaction time of upper extremity and competitive performance of male Taekwondo athletes[10].

Chung and Gabriel[33] maintained professional Taekwondo subjects participating in long term practices had better neuromotor performance in comparison with novice subjects, which is manifested by faster reaction time in special sport situations and better physiological performance with higher excitability of fatigued muscles. They found professional Taekwondo athletes react to particular non-sport stimuli in shorter time than amateur athletes and non-athletes, which suggests reduced sensitivity to unrelated sensual signals after prolonged high-intensity exercise.

Lower extremity flexibility of male Taekwondo athletes in Iranian national team for weights 1-4 for bending forward was 45, 39, 41, 42, and overall 41.75, respectively. Flexibility is very important in Taekwondo. Flexibility allows Taekwondo athlete to perform appropriate leg kicks in high speed in the whole range of joint motion. McArdle[8] and other studies emphasize that only flexibility of hamstring and lower extremity muscles are for investigating practices of Taekwondo. In comparison of findings by above works and current one, flexibility of Iranian national team of Taekwondo is higher than the norm proposed by the above authors. Hence, it can be said one reason for success of

Iranian Men National Taekwondo Team can be attributed to this physiological factor. Characteristic of Taekwondo id inclusion of rapid and high leg kicks which require flexibility and power. Thus, lower extremity muscles are determining in kicks, jump and explosive stop.

Trunk flexibility of Iranian Men National Taekwondo Team in weights 1-4 for bending backward was 65.50, 59.07, 54.77, 61.60, and overall 60.23 cm, respectively. Previous studies on flexibility by such authors as Cromwell et al., Heller et al., Markovic et al., Noorul et al. all were carried out using sit and reach test to evaluate trunk flexibility. Taekwondo practices have useful effect on improved weights[7,8,10,34]. Brudnak et al.[26] indicated participation in 17 weeks of Taekwondo practices led to improved trunk flexibility in aged subjects with average age 71 years.

Agility profile of Iranian Men National Taekwondo Team in weights 1-4 for passing 36 m distance (4×9) was 8.90 in weight 1, 8.37 in weight 2, 8.50 in weight 3 and 8.26 in weight 4, and 8.50 s in overall. Agility and success are highly related[19]. Since *Illinois* Agility Run *Test* was used for agility measurement in sports fields in other studies, there is no possibility for comparison of this index both in Taekwondo athletes and in other sports fields. However, it can be stated considering necessity for rapid movement and reaction against attacks, agility plays important role in success of Taekwondo athletes and it should be included in practices.

Conclusion

Physiological characteristics play considerable role in performing Taekwondo actions and kicks. Accelerating, stopping and restarting require muscle power, forward and backward jump movements, and abrupt jump require maximum power, sudden movements to the opponent need speed, fast constant kicks and fast repeated forward and backward leg movements need muscle strength and muscular strength and endurance in power. Also repeated forward and backward bending and side bending along with extreme widening of the trunk requires trunk flexibility and muscle strength and jump movements toward opponent need high flexibility in lower extremity. According to current work, Iranian Men National Taekwondo Team outperform in power, trunk and lower extremity flexibility, speed and aerobic power factors compared to Taekwondo athletes in other countries which may influence their performance at international competition levels. Finally, considering existing status based on findings by the current work, coaches and trainers and authorities of Taekwondo can evaluate effectiveness of their practices and progress in the respective factors in future years.

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