fizjoterapia polska
nr 3/2016 (16)

Funkcjonalna ocena wzorców ruchowych u zawodników wybranych sztuk i sportów walki z wykorzystaniem testu Functional Movement Screen™

Functional assessment of movement patterns in selected martial arts and sports contestants, using the test Functional Movement Screen™

Ewa Kamińska[1(A,C,D,E)], Sonia Porzucek[1(A,B,D,E,F)], Marzena Wiernicka[1(C,D)], Magdalena Goliwąs[2(D,F)], Jacek Lewandowski[2(G)]

[1]Akademia Wychowania Fizycznego w Poznaniu, Katedra Rehabilitacji Narządu Ruchu, Zakład Kinezyterapii, Poznań, Polska/ Physical Education Academy in Poznan, Motor Organ Rehabilitation Department, Kinesiotherapy Institute, Poznan, Poland
[2]Akademia Wychowania Fizycznego w Poznaniu, Katedra Rehabilitacji Narządu Ruchu, Zakład Rehabilitacji Narządu Ruchu, Poznań, Polska/ Physical Education Academy in Poznan, Motor Organ Rehabilitation Department, Poznan, Poland

Streszczenie

Cel pracy. Functional Movement System™ to koncepcja stworzona przez Cooka i Burtona, która umożliwia funkcjonalną ocenę wzorców ruchowych. Celem pracy było porównanie jakości wzorców ruchowych u zawodników trzech dyscyplin sportowych, wykrycie słabych ogniw w łańcuchu kinematycznym. Ponadto próbowano określić, który obszar narządu ruchu jest najbardziej narażony na występowanie nieprawidłowych wzorców ruchowych u zawodników poszczególnych dyscyplin.
Materiał i metodyka. W badaniu dokonano oceny wzorców ruchowych 60 zawodników trenujących boks, judo i kickboxing za pomocą testu FMS™, w tym 20 kobiet i 40 mężczyzn, w wieku od 18 do 30 lat. Badanych podzielono na trzy grupy, gdzie kryterium kwalifikacji do poszczególnych grup był rodzaj uprawianej sztuki lub sportu walki oraz staż treningowy.
Wyniki. Różnice pomiędzy bokserami, kickboxerami a judokami zaobserwowano jedynie w obrębie poszczególnych wzorców ruchowych. Ich globalna jakość była porównywalna w przypadku wszystkich sportowców.
Wnioski. Wyniki końcowe testu FMS™ nie różniły się istotnie statystycznie ze względu na rodzaj uprawianej sztuki lub sportu walki. U judoków stwierdzono najwięcej asymetrii podczas wykonywania poszczególnych testów, aż 30% badanych uzyskało najniższy średni wynik w testach FMS™, co sugeruje wdrożenie treningu korekcyjnego. Obszarami, które najbardziej były narażone na przeciążenia u bokserów i kickboxerów okazały się odcinek lędźwiowy kręgosłupa oraz okolica stawu ramiennego, a u bokserów tylko odcinek lędźwiowy kręgosłupa.

Słowa kluczowe:
profilaktyka urazów, FMS™, judo, boks, kickboxing

Abstract

Purpose of this study. Functional Movement System™ is a concept created by Cook and Burton, that allows functional evaluation of movement patterns. The purpose of this study was to compare movement patterns in contestants of the three sports disciplines, determination of weak links in the cinematic chain. Additionally, it was attempted to determine which motor organ is most exposed to incorrect movement patterns in contestants of individual disciplines.
Material and methods. In the study evaluation included movement patterns of 60 contestants that train box, judo and kickboxing by means of FMS™, including 20 women and 40 men, at the age from 18 to 30 years. The investigated persons were divided in three groups, where qualification criterion for each group was type of trained martial art or sport and training seniority.
Results. Difference between boxers, kickboxers and judokas were observed only within individual movement patterns. Their global quality was comparable for all persons.
Conclusions. Final results of FMS™ test were not statistically significantly different due to type of trained martial art or sport. In judokas it the most asymmetry was during individual tests, as many as 30% of investigated receive the lowest average result in FMS™ tests, that suggest implementation of corrective training. The areas that were most exposed in boxers and kickboxers appeared to be spine lumbar section and shoulder joint area, and in boxers only spine lumbar section.

Key words:
injury prophylactics, FMS™, box, judo, kickboxing

Introduction

Probability of injury increases among still growing number of persons that train martial arts and sports. Many injuries are caused during sport fight due to direct force generated by the opponent [1, 2, 3, 4]. Many authors noticed incorrect sport technique of contestants, insufficient central stabilization and unsuitable level of motor abilities [3, 4]. So, it is recommended to modify exercises in such way that in addition to elements characteristic for given discipline, they also included prevention of injuries [2, 3, 4]. To allow such proceeding, first it is required to determine factors that predestine to injuries. For this purpose we may use developed in 1995 by Gray Cook and Lee Burton Functional Movement System™ (FMS™) [5, 6]. This method consists in care of correct performance of movement patterns, and rejects training model and motor organ examination based isolated body parts [6, 7, 8]. The authors also assumed that the training and physiotherapy foundation is care of correct movement pattern, and only on its base to shape motor abilities and sport technique [6, 8, 9]. Main purpose of Functional Movement System™ is screening test of the motor organ, indication of weak points in biokinematic chain and correction of asymmetry and incorrect movement pattern in global view [5, 6, 8, 9]. Existence of any weak link in biokinematic chain is very undesirable. It leads to compensation, microtraumas and overloads [2, 3, 4, 6, 8, 9, 10]. Many authors state that FMS™ is effective in identification of weak links [5, 6, 8, 9, 11, 12, 13, 14, 15, 16]. However, it must be noted that FMS™ is not any diagnostic tool, but it is designed for screening test, so it should be treated as an evaluation element of the contestants' health and efficiency condition [6, 8, 9, 16].

Purpose of this study

Taking into account the final result of FMS™ test, that allows identification the risk of injury, the purpose of this study was to compare movement patterns in contestants of the three sports disciplines, determination of weak links in the cinematic chain. Additionally, it was attempted to determine which motor organ is most exposed to incorrect movement patterns in contestants that train box, kickboxing and judo.

Material and methods

The investigated group included 60 women at the age 18-30 years. The investigated persons were divided in three groups, where qualification criterion for each group was type of trained martial art or sport and training seniority and general good health condition. Excluded were persons after injuries or who had muscle-skeleton pain ailments or that were during pharmacological treatment. They were contestants from sports clubs near Poznan. All investigated gave aware consent for examination using FMS™ test.

In research 20 women took part at the average age 22.05±2.7 Women trained box 2-3 times a week for average period 3 months. Body mass index in 19 of them was in the range 18.5-24.9 classified as a norm value [17]. In one of

investigated BMI was 28.2, what according to WHO classification is overweight [17]. The second investigated group included 20 men at the average age 24.2±3.4 that trained kickboxing. The sportsmen trained on average 28 months, 3 times a week. All investigated men, according WHO standard, had correct body mass, as their BMI values were in the range 18.5-24.9 [17]. The third investigated group included men at the average age 23.1±3.7 that trained judo. They had bigger training experience than women, it was on average 22 months. They trained 3 times a week. The body mass index in 18 persons was according to norm (18.5-24.9) [17]. The BMI value in one person indicated underweight (it was 18.2), and in the second one – overweight (BMI value was 28.3) [17].
Essential statistical differences were found in body mass (p=0.0002) and body height (p=0.0001) and training seniority (p=0.0000) between boxers and kickboxers and judokas. Kickboxers and judokas were uniform statistically groups within analyzed anthropometric parameters (Tab. 1.).

Tab.1. Anthropometric characteristics of investigated persons in individual groups

Anthropometric characteristics of investigated persons n=60	Mean±SD	Median	Range	W	p
Box n=20					
Age (years)	22.5±2.7	21.5	18-27	0.947	0.324
Body Weight (kg)	66.7±7.4	66.5	55-81.5	0.953	0.428
Body Height (cm)	166.4±7.2	169	155-181	0.977	0.895
Training seniority (months)	2.8±0.35	3	1.5-3	0.40	0.000
Kickboxing n=20					
Age (years)	24.2±3.4	23.5	19-30	0.95	0.439
Body Weight (kg)	77.6±7.6	76.75	64-91	0.97	0.757
Body Height (cm)	182±6.7	181.5	172-196	0.91	0.568
Training seniority (months)	28.1±15.9	24	12-16	0.86	0.011
Judo n=20					
Age (years)	23.1±3.7	23	18-30	0.94	0.324
Body Weight (kg)	77.7±9.1	79	59.5-100	0.97	0.907
Body Height (cm)	182.5±8.1	181.5	170-205	0.94	0.260
Training seniority (months)	22.55±11.28	18	12-48	0.82	0.000

For functional evaluation of movement patterns the test Functional Movement Screen™ was used [5,6].
The tool used for research included seven tests that were made three times by an investigated person. Tests made by each investigated person included: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, rotatory stability [6, 9].
In total in the test one could get maximally 21 points. In case of receiving total points from all tests 13-0 points,

the correction training is implemented. On the basis of strictly defined criteria, the same physiotherapist evaluated quality of performed movements in each test in the points scale 0-3.
The best performed trial was evaluated. In case of asymmetrical tests, the lower note from the two received was considered. The highest mark was given when the presented pattern was correctly performed and during the exercise the persons had no pain ailments. In the event when the tested person performed movement task using compensation, i.e. incorrectly, the tester gave 2 points. 1 point note was given in case, when the tested persons was not able to perform particular movement. Test was evaluated as 0 points, when during trial the tested person felt pain [6, 9].
For Functional Movement Screen™ test required equipment include a board, crosspiece, two poles and stick with defined dimensions. Before each trial, the tester discussed each test, but so that not to suggest the tested persons how exactly perform the movement task. It was aimed to make possible to present natural pattern by the tested person.
The results were subject to statistical analysis using the software STATISTICA 10.0. To compare results obtained in individual FMS™ tests and final results in each group, Pearson independence test chi2 was used, assuming the when $p<0.05$ the result is statistically significant.

Research results

The first test was deep squat test . No statistically significant differences were found among investigated groups of contestants $p=0.0680$. Among box training persons the highest note was received by 8 persons, which is 40% of the group. The same result among kickboxers received 4 tested persons (20%). The same, because 4 contestants (20%) of judo received note 3 in test. The note equal 2 was received by 8 boxers, which is 40%, 14 (70%) kickboxers and 16 (80%) judokas. 4 (20%) boxers received 1 point for the deep squat test. The same points number (1) received 2 sportsmen, which is 10% of kickboxers. Among judo training persons, no one received such number of points. In all three groups no 0 points result was recorded.
Next test was hurdle step . No statistically significant differences were found among investigated groups $p=0.2801$. The highest result was noted in 6 (30%) boxers, 6 (30%) kickboxers and 4 (20%) judokas. Test result 2 points was given to 14 (70%) boxers, 12 (60%) kickboxers and 16 (80%) judokas. Two kickboxers, which is 10%, received 1 point in the test. Such situation took no place in case of persons who trained box and judo. For no group the lowest possible note was recorded. Fifteen box contestants, which is 75% of the group, featured the same note for left and right side. Symmetrical results were also given to 16 kickboxers (80%) and 14 judokas (70%). Asymmetric results (for left and right

sides) were noted in 5 boxers (25%), 4 kickboxers (20%) and 6 judokas (30%).

In the in-line lunge test also no statistically significant differences were found among investigated groups p=0.1644. The results were as follows: 3 points received 10 (50%) boxers, 12 (60%) kickboxers and 14 (70%) judokas. Test result 2 points was given to 6 (30%) boxers, 4 (20%) kickboxers and 6 (30%) judokas. 1 points received 2 (10%) boxers, 4 (20%) kickboxers and 0 (0%) judokas. The result 0 points was only in box training group in 2 sportsmen, which is 10% of this group. The same notes for right and left side were determined among 18 boxers (90%), 20 kickboxers (100%), and 16 judokas (80%). Asymmetric patterns were found in 2 boxers (10%), 4 judokas (20%).

Then the pattern of shoulder mobility was tested . Highly statistically significant differences were found between three investigated groups p<0.0001. 3 points received 18 (90%) boxers, 6 (30%) kickboxers and 4 (20%) judokas. Lower mark (2 points) was given to 2 boxers (10%), 10kickboxers, which is 50% and 4 (20%) judokas. Test was evaluated for 1 point only in case of 6 (30%) judokas. The lowest mark (0 points) received 4 (20%) kickboxers, 6 (30%) judokas. Symmetrically performed pattern was presented by 18 boxers (90%), 11 kickboxers (55%) and 12 judokas (60%). The movement task was performed asymmetrically by 2 boxers (10%), 9 kickboxers (45%) and 8 judokas (40%)

The active straight leg raise test results were statistically significantly different among investigated groups p=0.330. The highest note (3 points) received 14 (70%) boxers, 8 (40%) kickboxers and 6 (30%) judokas. Note 1 point lower (i.e. 2 points) received 6 (30%) boxers, 10 (50%) kickboxers and 12 (60%) judokas. One point was given only to 2 judo contestants (10%). The lowest mark received 2 kickboxers (10%) (Fig.8.). Test performed with the left and right lower limb was evaluated equally in 19 boxers (95%), 17 kickboxers (85%) and 15 judokas (75%). Different marks for the left and right side were in 1 boxer (5%), 3 kickboxers (15%) and 5 judokas (25%).

The trunk stability push-up test was performed . Highly statistically significant differences in results were found for the three investigated groups p<0.0001. The pattern was evaluated for 3 points in 6 (30%) kickboxers, 12 (60%) judokas, but no one boxer. 2 points received 6 (30%) boxers, 2 (10%) kickboxers and none of judokas. Four box contestants received 1 point, which is 20% of the group. No one kickboxer or judoka was evaluated for 1 point in this test. The mark 0 points was given to 10 (50%) boxers, 12 (60%) kickboxers and 8 (40%) judokas.

The last test was rotatory stability test . Statistically significant differences were found between three investigated groups p=0.0239. The highest result was noted in 4 (20%) boxers, 12 (60%) kickboxers and 6 (30%) judokas. The pattern was evaluated for 2 points in case of 16 (80%) boxers, 8 (40%) kickboxers and 14 (70%) judokas. Lower notes, i.e. 1 and 2 points were not recorded in any group. Symmetrically performed pattern was presented by 18 boxers (90%), 17 kickboxers (85%) and 18

judokas (90%). Asymmetrically performed pattern was presented by 2 boxers (10%), 3 kickboxers (15%) and 2 judokas (10%).
The test final results were assessed according to criterion proposed by Cook [18]. The mark in range 21-18 points was received by 2 boxers (10% of this group), 2 kickboxers (10%) and 4 judokas (20%). In lower range of marks, i.e. 17-14 located were 16 boxers (80%), 16 kickboxers (80%) and 10 judokas. Result below 14 points was received by 2 boxers (10%), 2 kickboxers (10%) and 6 judokas (30%). Received final results were not statistically significantly different among investigated groups p=0,2056 (Tab.2.).

Table 2. Final result of FMS™ test received in three tested groups

Final result of FMS™ test received by tested persons (p=0.205)			
Results of FMS™ test (points)	Box n/%	Kickboxing n/%	Judo n/%
In range 21-18	2/10	2/10	4/20
In range 17-14	16/80	16/80	10/50
In range 13-0	2/10	2/10	6/30

Discussion

Basic goals of this study was evaluation of movement pattern in persons that train martial arts and sports and comparing results from seven tests FMS™ received in three groups of contestants. Final results of FMS™ test were not statistically significantly different due to type of trained martial art or sport. Differences between boxers, kickboxers and judokas were observed only within individual movement patterns. Their global quality was comparable for all persons, women and men.

Taking into account scoring in FMS™ test, results of numerous investigations indicated that persons who received 14 points or less were more exposed to injuries than athletes with note higher than 14 [5, 8, 12, 14, 15, 22]. Benenson et al. demonstrated that the risk of injury is then 15 times higher [12], and Bouillon et al. that 4 times higher [8]. Hadadnezhad et al. as a threshold value determined 17 points [11]. Cook in his publication defined three ranges of scores. According to him, result at the level of 18-21 points is characteristic for a person with correct movement pattern and minimal risk of overload, the range 14-17 includes tested persons with disturbed patterns and the injury risk rises by 25-35%. Final result below 14 points indicates even bigger irregularities and the risk of micro-trauma is bigger by 50% comparing to persons from the first scoring range [18].
The test final results of this study were assessed according to criterion proposed by Cook [18]. It must be noted that final results received in this research are similar to results received by Schneiders et al. and showed similar results for tested women and

men at the age interval 18-40 years [23]. Definitely most of tested persons received result between 17 and 14 points, since as many as 80% persons of the two groups. It means that most athletes will be exposed to microtraumas in the future. Boxers and kickboxers who are trained to fight in standing position presented in general the same quality of movement patterns. Other results were received by contestants that fight in standing and kneeing or lying position, that is judokas, because 30% of them received less than 14 points, what significantly increases risk of injuries in this group. In addition, most movement patterns were made partially asymmetrically, e.g. hurtle step 30%, deep squat 20%, shoulder mobility 40%, active straight leg raise 25%, trunk stability push-up 40% and the last one rotatory stability 10%. Comparing results received by boxers and kickboxers the least number of asymmetrical patterns was found among boxers. Some authors underlined that particularly essential from the injury prophylactics point of view is lack symmetrical movement patterns [5, 8, 9, 10, 14, 18]. According to Arnold et al. if in one of the seven tests the result will be different for left and right side of body the trauma risk rises two, three times, regardless final scoring [14]. That is why, taking into account final results for 10% of boxers, 10% kickboxers and 30% judokas in the lowest scoring range and existence of asymmetrical patters, particularly in the last group, it must be said that they are highly exposed to injuries and should receive correcting training.

Additionally, it was attempted to determine which motor organ is most exposed to incorrect movement patterns in contestants of individual disciplines.

Results received in judokas group indicated that most presented by them movement patterns was incorrect, excluding active straight leg raise. Compensation and weak links in kickboxers' movement patterns must be always considered as common. The lowest results in this group were noted in the trunk stability push-up test. As many as 60% tested persons reported pain feeling during the movement task and received 0 points. Results from the shoulder mobility test indicated the fact that asymmetry was found in 45% kickboxers, and 20% of them reported pain ailments. Areas of the motor organ most exposed to weak links were the same in judokas group, since 40% performed the pattern asymmetrically and 30% indicated pain.

The tests in which half or more boxers received the highest score were the in-line lunge test and the shoulder mobility test. The rest of patterns was evaluated lower, what indicates weak links in biokinematic chains. The lowest results were noted in the trunk stability push-up test. Half of the boxers complained about paint in the spine lumbar section. Therefore, it may be assumed that it was the area most exposed to weak links in this group of athletes.

Boscolo Del Vecchio, Calmet et al. in their work indicated that the knee joint, shoulder joint and hand are areas of motor organ where injuries occur most often in judokas [2]. Analysis of performed tests demonstrated that they were partly in compliance with the results of this study. As it was proven that judokas' movement patterns which involve the shoulder joint and adjacent joints were often disturbed and their performance not rarely was accompanied by pain ailments. In addition, it was demonstrated that equally sensitive area of the motor organ was the spine lumbar section. The use of FMS™ test to evaluate the martial art and sports contestants' movement pattern allowed to find undesired compensations in biokinematic chain. The same observations were made in their works by, among others, Bouillon, Chorba et al. [8, 24].

Conclusions

1. Final results of FMS™ test did not demonstrate any statistically significant differences in quality of performing tested movement patterns by persons who train box, kickboxing and judo.
2. The highest percent of asymmetry at individual patterns was observed for judokas, what according to Cook increases by 50% the risk of contusion and injuries in this group of athletes, comparing to those who received best results, and it suggests to implement corrective training.
3. The areas that were most exposed in tested judokas and kickboxers appeared to be spine lumbar section and shoulder joint area, and in boxers only spine lumbar section.

Adres do korespondencji / Corresponding author

dr Ewa Kamińska

Akademia Wychowania Fizycznego,
Zakład Kinezyterapii,
ul. Królowej Jadwigi 27/39 60-871 Poznań,
kaminska@awf.poznan.pl

Piśmiennictwo/ References

1. Graham P., Lystad R., Swain M.: Risk factors for injury in Olympic-style competition taekwondo: a systematic review. The Journal of Sports Medicine and Physical Fitness 2013, 6, 655-664.
2. Boscolo Del Vecchio F., Calmet M., Gutierrez-Garcia C., i wsp.: Injuries in judo: a systematic literature review including suggestions for prevention. British Journal of Sports Medicine, 47, 2013, 1139-1143.
3. Alizadeh MH., Sedaghati P., Shirzad E.: Epidemiology of head, neck and torso injuries in taekwondo, karate and judo. Journal of Kashan Univeristy od Medical Sciences, 4, 2012, 368-385.
4. Lachlan P.: Injury Prevention Strategies for Mixed Martial Arts. Strength and Conditioning Journal, 5, 2014, 88-95.
5. Biernat R., Biernat U., Godlewski J. i wsp.: Zastosowanie testu funkcjonalnej oceny w praktyce. Praktyczna Fizjoterapia i Rehabilitacja 2013, 39, 4-11.
6. Burton L., Cook G., Hoogenboom B., Voight M.: Functional Movement Screening: the use of fundamental movements as an assessment of function – part 1. The International Journal of Sports Physical Therapy 2014, 3, 396-409.
7. Erdmann W.S., Zieniawa R.: Wybrane elementy biomechaniki sportu. Biomechanika Judo. Wydawnictwo uczelniane Akademii Wychowania Fizycznego i Sportu w Gdańsku, Gdańsk 2012.
8. Bouillon L., Chorba D., Chorba R., Landis J., Overmyer C.: Use of a functional movement screening tool to determine injury risk in female collegiate athletes. North American Journal of Sports Physical Therapy, 2, 2010, 47-54.
9. Burton L., Cook G., Hoogenboom B., Voight M.: Functional Movement Screening: the use of fundamental movements as an assessment of function – part 2. The International Journal of Sports Physical Therapy 2014, 4, 549-563.
10. Burden A., Fowler N., Grimshaw P., Lees A.: Mechanizmy urazów. Biomechanika sportu. Wydawnictwo Naukowe PWN, Warszawa 2010.
11. Hadadnezhad M., Letafatkar A., Mohamadi E., Shojaedin S.: Relationship between functional movement screening score and history of injury. The International Journal of Sports Physical Therapy 2014, 1, 21-27.
12. Benenson J., Garrison M., Johnson M., Westrick R.: Association between the Functional Movement Screen and injury development in college athletes. The International Journal of Sports Physical Therapy 2015, 1, 21-28.
13. Adamczyk J., Białoszewski D., Boguszewski D., Pepłowski M.: Ocena funkcjonalna zawodników uprawiających podnoszenie ciężarów z zastosowaniem testu Functional Movement Screen. Medycyna Sportowa 2012, 4, 267-276.
14. Arnold T., Chapman R., Laymon A.: Functional Movement Scores and Longitudinal Performance Outcomes in Elite Track and Field Athletes. International Journal of Sports Physiology and Performance, 9, 2014, 203-211.
15. Bruner J., Durall C., Flanagan M., Krumrei K.: The Accuracy of the Functional Movement Screen to Identify Individuals With an Elevated Risk od Musculoskeletal Injury. Journal of Sport Rehabilitation, 23, 2014, 360-364.
16. Beardsley C.: The Functional Movement Screen: a review. Strength and Conditioning Journal, 5, 2014, 72-80.
17. Basdevant A., Finer N., Fried M. i wsp.: Postępowanie w otyłości dorosłych: europejskie wytyczne dla praktyki klinicznej. Endokrynologia, Otyłość i Zaburzenia Przemiany Materii 2009, 3, 87-98.
18. Cook G.: Movement – Functional Movement System. Ontarget Publications, 2012.
19. Kubacki R., Maśliński J., Witkowski K.: Kompendium Judo Tom 1: Podstawy Tachi-Waza. AWF Wrocław, Wrocław 2009.
20. Nowak T.: Boks – technika, metodyka nauczania. AWF Warszawa, Warszawa 2008.
21. Boykin C.: Muay Thai. Kickboxing. Budo-Sport, Warszawa 2009.
22. Bodden J., Chockalingam N., Needham R.: The effect of an intervention program on functional movement screen test scores in mixed martial arts athletes. The Journal of Strength and Conditioning Research 2015, 1, 219-225.
23. Schneiders AG, Davidsson A, HormanE, Sullivan SJ. Functional movement screen normative values in young, active population. International Journal of Sports Physical Therapy 2011;6(2):75-82.
24. Chorba RS, Chorba DJ, BouillonLF, Overmeyer CA, Landis JA. Use of a functional movement screening tool to determine injury risk in female collegiate athletes. North American Journal of Sports Physical Therapy 2010;5(2):47-54.