



Full Length Research Article

GRIP STYLE, GRIP SIDE ON LEG DOMINANCE IN ACL INJURIES AMONG JUDO PLAYERS

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ABSTRACT

Background: The growing popularity of sports and exercise is focusing attention on the injuries that may occur in addition to the health benefits. Judo one of the Japanese traditional martial arts in now the most widely practiced martial arts in the world. Judo includes at least four technical aspects throw, hold down, choke and arm lock. Each of which could impose large stress on various anatomical structures. Objectives of this study were to elucidate difference in ACL injuries between dominant and non dominant legs of the judo players. Second objective was to find out association of grip style, grip side technique which provides injury on leg dominance in ACL injuries in judo players. To find out difference in the number of ACL injury incidence between two grip style (KENKA-YOTSU STYLE and AI-YOTSU STYLE). To find out difference in number of ACL injury incidents between grip side on leg dominance (Right side and Left side)

Methods: A Total of 82 subjects who fulfilled the inclusion and exclusion criteria were included in the study. Study was review all ACL injuries reported to the physiotherapists affiliated with the national professional, coaches, collegiate and youth judo players. Subject who fulfils, inclusion and exclusion criteria was assessed by questionnaire and interview. A judo player with 20 year experience had carry out interview to acquire information on ACL injury incidence with regard to situations

Results: Showed the difference in number of ACL injury incidence between dominant side and non dominant side was statistically significant. ($X^2=17.24$, $p<.0001$). The difference in the number of ACL injury incidents between the two grip styles was not statistically significant ($X^2=2.56$, $p>.10$). The ACL injury occurrence when being attacked was greater than when being counterattacked than when attempting an attack however this was not statistically significant ($X^2=3.7$, $p>.05$). The result showed that direct contact technique was significantly greater than the indirect technique mechanisms ($X^2=29.64$, $p<.0001$).

Conclusions: Results suggest that there was no significant difference in grip style, grip side and judokas behaviour on leg dominance in ACL injuries among judo players but there was significant differences with the technique that caused the ACL injury in judo players.

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INTRODUCTION

The growing popularity of sports and exercise is focusing attention on the injuries that may occur in addition to the health benefits. Treating sports injuries may be expensive, so preventive strategies and measures are required on economic as well as medical grounds¹. The ACL attaches in front of the intercondyloid eminence of the tibia, being blended with the anterior horn of the medial meniscus. These attachments allow it to resist anterior translation and medial rotation of the tibia, in relation to the femur.²

The ACL is usually torn as a result of a quick deceleration, hyperextension or rotational injury that usually does not involve contact with another individual. This injury often occurs following a sudden change of direction. A person typically reports feeling a popping sensation in the knee. When hit from the side, injuries to ACL are often associated with medial meniscus and medial collateral ligament (MCL) tears.³ Judo one of the Japanese traditional martial arts in now the most widely practiced martial arts in the world. Judo includes at least four technical aspects throw, hold down, choke and arm lock. Each of which could impose large stress on various anatomical structures. For a successful throws a judoka needs to manipulate the Centre of mass of the opponent relative to the base of support and make their opponent land on their back with speed gathered in the fall as a consequences.

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The study also showed that fresh men judokas had experienced a history of knee injury and also reported multiple episodes of knee injury in the pre-seasoned physical examination. Anterior cruciate ligament injury may be the most serious knee injury in judo.⁴

A study showed that majority of ACL injuries occurred in non-contact situations such as in cutting, stopping and jump landing. It is necessary to understand the mechanism of ACL injury in specific sports to establish a preventive strategy.⁵ Studies have suggested lower limb dominance as a possible etiological factor in predicting ACL injury because the joints of the non-dominant limb were thought to be more unstable during manoeuvre. Excessive translational shear forces, internal rotations and valgus movements at knee during cutting have been identified as possible kinetic stresses that place increased strain on the ligament of the pushing leg.⁶ A study conducted by Tetsuya Onda analyzed body composition between right and left handed grip. Results showed that there were some differences between the right hand judo players and left hand judo players especially in the lower limb. It also showed that left handed grip judo players had a heavier right leg compared to their left leg.⁷

The study found that knee injuries were mostly affected in most cases in the fresh man and the less cases in the senior students.⁸ The probability of meniscal injury is high because there is ACL insufficiency (13.8%) female.⁹ Judokas are advised not to lose weight before a competition as this increases the risk of injury grade or weight category are associated with an increase in injury rate.¹⁰ A study showed that there was no significant difference in measurement between right hops and left hops.¹¹ Numerous prevention programs have been devised in order to address the patho kinematics surrounding the mechanism of injury which has been successful in reducing the rate of injury.¹² Ettlinger *et al* developed an education programme for ACL injury prevention in alpine skiers to make skiers recognise dangerous situations with an aim to aid injury avoidance and reported that the rate of ACL injury occurrence in highly skilled alpine skiers decreased through the use of the education programme.¹³

ACL insufficiency is made medial meniscal injury easy to cause, significant differences between medial and lateral meniscal injury is not seen because ACL insufficiency is not present. There were some differences between the right handed judo players and left handed judo players especially in the lower limb.¹⁴ Anterior knee joint laxity is not related to the functional capacity of the athlete and that static assessments do not assess the role of secondary restraints. Knee injury is one of the most frequent troubles for the judo players and severely influences the judo activity.¹⁵ A study showed that grip style may be associated with ACL injury occurrence in judo and direct contact due to the opponent's attack may be a common mechanism for ACL injuries in judo. Knee is the most commonly injured joint in the high risk sports of soccer and rugby. Acute knee injury is the commonest cause of permanent disability after a sport injury.¹⁶ It may be necessary to develop an ACL injury awareness programme specifically for judo.

An education program may also help judokas recognize and avoid situations of high risk for ACL injury in judo.⁴ So there

exists here to find out the difference in grip style, grip side on leg dominance in ACL injuries among judo players. Objectives of this study were to elucidate the difference in ACL injuries between dominant and non-dominant legs of the judo players. To find out the association of grip style, grip side technique which provides injury on leg dominance in ACL injuries in judo players. To find out the difference in the number of ACL injury incidence between two grip styles (KENKA-YOTSU STYLE and AI-YOTSU STYLE). And to find out the difference in the number of ACL injury incidents between grip side on leg dominance (Right side and Left side). We performed a cross tabulation analysis to elucidate the inter-relationship between the grip style, grip side and technique on leg dominance in ACL injury among judo players.

MATERIALS AND METHODS

The study was conducted at Thrissur district sports council and judo association coaching centre, Sports Authority of India, Thrissur. The ethical clearance has been obtained from the Ethical committee, as per ethical guidelines for research from biomedical research on human subjects, 2001, ICMR, New Delhi. The study design was a comparative evaluation study. A total of 82 subjects were taken. All of the subjects were judo players, who fulfilled the inclusion criteria of athletes who had sustained a complete ACL tear or a partial tear due to direct participation in either a game or practicing in judo. Exclusion criteria were under the age of 12, athlete who had an ACL reconstruction, subjects who are ambidextrous, and athletes who had a bilateral ACL tear. Procedure includes: Study was reviewed, all ACL injuries reported to the physiotherapists affiliated with the national professional, coaches, collegiate and youth judo players.



Figure 1. AI-YOTSU Grip Style

AI-YOTSU grip style: In which a judoka and the opponent have the same grip side.

A judo player with 20 years experience had carried out an interview to acquire information on ACL injury incidence with regard to situations. Interviews and questionnaires contain the details of participants' characteristics (age at incidence, gender, grip side), injury characteristics (when the injury occurred, surgical

or non-surgical intervention injury side other complication.) Grip style (AI-YOSTU STYLE (Fig 1), KENKA YOSTU (Fig 2)), judokas behaviour (attempting an attack (Fig 3), being attacked (Fig 4), and being counter attacked (Fig 5)), and injury mechanism- technique that directly caused the injury (Direct contact, indirect, injury and others). Direct contact, indirect contact and non-contact injuries were operationally defined as contact with the injured extremity, contact with any part of the body except the injured extremity and no contact with the opponent, respectively. Dominance was assessed by lateral preference inventory. (Adapted Waterloo Footedness Questionnaire).



Figure 2. Kenka-Yotsu Style

KENKA-YOTSU grip style: In which a judoka and the opponent have different grip sides



Figure 3. Attempting an Attack

ATTEMPTING AN ATTACK: In which a judoka is trying to attack the opponent

Data once collected was summarized as percentages. Data was analyzed to find out the whether judokas grip style, grip side and behaviour will produce ACL injury of dominant or non-dominant leg. Data analysis was performed using SPSS software (version 17). Alpha value was set at 0.05. Descriptive statistics was used to measure baseline data for demographic

and outcome. Chi square test as a test of association was used to analyze the influence of grip style, grip side, judokas behavior on dominance of ACL injuries. Chi square test as a goodness of fit was used to analyze number of ACL injuries incidence between dominant and non dominant side, between grip style (right Vs left), between judokas behavior (attempting an attack Vs being attacked), technique used (direct Vs indirect), Microsoft word, excel is used to generate graph and tables etc.



Figure 4. Being attacked

BEEING ATTACKED: In which judoka is being attacked by the opponent



Figure 5. Being Counter Attacked

BEING COUNTER ATTACKED: In which a judoka is counter attacked by the opponent

RESULTS

In the study the demographic variables considered were age, weight, experience, age at the time of incidence and experience at the time of injury. Out of 82 participants 64 judo players had right handed grip (78.0%), and 18 judo players had

left handed grip (22.0%). Out of 82 participants included in this study 39 judo players got injured leg on the dominant side(47.6%) ,9 judo players got injured leg on non dominant side(11.0%) where as 34 judo players never got an injured leg. Out of 48 participants included in this study 13 got ACL injury while attempting an attack (27.1%), 26 got ACL injuries while being attacked (54.2%), and 9 players got ACL injury while being counter attacked (18.8%). A total of 14 ACL injuries occurred in the kenka-yotsu style (35.9%) (The participant's grip side was different from their opponent's) whereas 25 ACL injuries occurred in the ai-yotsu style (64.1%) (The participant grip side was the same as their opponent's).In all 39 injuries 37 cases of direct contact injury occurred (94.9%) where as 2 cases of indirect injury occurred (5.1%), no non contact injury where observed in the investigation.

The difference in number of ACL injury incidence between dominant side and non dominant side was statistically significant. ($X^2=17.24$, $p<.0001$).Out of 48 ACL injuries there were 39 injured on the dominant side where as 9 ACL injuries on non dominant side (Table I). In the 39 dominant ACL injury 30 injuries produced due to right side and 9 injured produced left hand grip side. There was no association of grip side on dominant and non dominant ACL injuries ($p>.665$).

Table 1. Grip side Vs Injured leg cross tabulation

		Injured Leg		Total
		Dominant	Nondominant	
Grip Side	Left	9	2	11
	Right	30	7	37
Total		39	9	48

The difference in the number of ACL injury incidents between the two grip styles was not statistically significant ($x^2=2.56$, $p>.10$). In the 32 dominant ACL injury 18 injuries produced due to AI-YOTSU GRIP STYLE and 14 injured produced KENKA-YOTSU grip style(Table-II). In the 7non dominant ACL injures 7ACL injures produced due to AI-YOTSU grip style and there is no ACL injury occurred due to KENKA-YOTSU grip style. There was statistical significant association of grip style on dominant and non dominant ACL injuries. ($p<.031$). That means AI-YOTSU style produces more dominant injuries than non dominant injuries.

Table 2. GRIP style Vs injured leg cross tabulation

		Injured Leg		Total
		Dominant	Nondominant	
Grip Style	AI-Yotsu	18	7	25
	Kenka-Yotsu	14	0	14
	Total	32	7	39

The ACL injury occurrence when being attacked was greater than when being counterattacked than when attempting an attack however this was not statistically significant ($x^2=3.7$, $p>.05$). In the 32 dominant ACL injury 11 injuries produced while attempting an attack and 21 ACL injuries produced while being attacked , in 7 non dominant ACL injuries 2 ACL injury occurred while attempting an attack where as 5 ACL injuries occurred while being attacked (Table III). There was no statistical association between judokas behavior on dominant and non dominant leg injuries ($p>.571$).

Table 3. Judoka's Behavior Vs injured leg Cross tabulation

		Injured leg		Total
		Dominant	Nondominant	
Judoka	attempting an attack	11	2	13
	Being attacked	21	5	26
	total	32	7	39

The result showed that direct contact technique was significantly greater than the indirect technique mechanisms ($x^2=29.64$, $p<0001$). In the 32 dominant ACL injury 31injuries occurred due to direct injury and 1 ACL injury occurred due to indirect injury, In 7 non dominant ACL injuries 6 ACL injuries occurred as direct injury where as 1 ACL injury occurred as indirect (Table IV). There was no statistical association between technique which caused ACL injuries on dominant and non dominant leg injuries ($p>.331$).

Table 4. Technique Vs injured leg cross tabulation

		Injured Leg		Total
		Dominant	Non dominant	
Technique	Direct	31	6	37
	Indirect	1	1	2
	Total	32	7	39

DISCUSSION

Objectives of this study were to elucidate difference in ACL injuries between dominant and non dominant legs of the judo players. Second objective was to find out association of grip style, grip side technique which provides injury on leg dominance in ACL injuries in judo players. To find out difference in the number of ACL injury incidence between two grip style (KENKA-YOTSU STYLE and AI-YOTSU STYLE).To find out difference in number of ACL injury incidents between grip side on leg dominance .(Right side and Left side). We performed a cross tabulation analysis to elucidate the inter relationship between the grip style grip side and technique on leg dominance in ACL injury among judo players.

Descriptive statistics were used to find out base line and demographic data such as age group was 13-17, 18-22, 23-27, 28-32, weight category of 35 kg minimum and 120 kg maximum, experience of judo players was between one year and twenty year, ACL injury occurrence was in between 15 years and 25 year where as experience of the judo players at the ACL injury was between one year and 15 years. Out of 82 participants, 48 players had ACL injuries occurred. The difference in number of ACL injury incidences between dominant side and non dominant side was statistically significant ($X^2=17.24$, $P<.0001$). Out of these players 39dominant leg injured whereas 9 non dominant leg injured.

However study done by Zmago Krajnc *et al* shown that there is increased risk of knee injuries and early osteoarthritis occurs more in the non dominant leg. In their study 22 players got injury in non dominant leg and 14 players had suffered injury in dominant leg. However their study was conducted in foot ball players. In this study participants were judo players. The mechanism of injury in soccer players often involves faulty landing technique, deceleration, pivoting or cutting with

excessive anterior shear forces.¹⁷ However above mechanism apply only to injuries occur to soccer players. Yutaka Nakamura *et al* surveyed the anterior instability of knee and concluded that anterior knee joint laxity is noted under judo players.²³

The difference in number of ACL injury incidence between dominant side and non dominant side was statistically significant ($X^2=17.24, p<.0001$). In the 39 dominant ACL injury 30 injuries produced due to right side and 9 injured produced left hand grip side. In the 9 dominant ACL injury 7 injuries cause due to right side 2 injuries were due to left side. There was no association of grip side on dominant and non dominant ACL injuries ($p>.665$). Seji Aruga *et al* conducted a study to comprehend the ability of one leg squat by judo players, and author concluded that there was no significant correlation between 1 RM of one leg squat and 1 RM of both leg. As far 1RM of the one leg squat, the right leg significant indicates a higher scale than left leg.¹⁹ Tetsuya Onda *et al* analyzed the body composition of differences between right handed grip and left handed grip, and author concluded that left handed grip judo player had a heavier right leg compare to their left leg.²¹

Difference in the number of ACL injury incidence between two grip styles was not statistically significant ($X^2=2.5, p>.10$), number of ACL injury occurrence from AI-YOTSU style was significant greater than KENKA-YOTSU style. Out of 39 participants 25 AI-YOTSU, grip style players got ACL injured where as 14 KENKA-YOTSU grip style players ACL injured. Out of 32 dominant ACL injuries 18 were due to AI-YOTSU style 14 were due to KENKA-YOTSU style and out of 7 non dominant injuries all 7 were using AI-YOTSU style. There was statistical significant association of grip style on dominant and non dominant ACL injuries. ($p<.031$). That means AI-YOTSU grip style was more associated with dominant ACL injuries. However in a study done S Koshida *et al* shown that number of ACL injury occurred from KENKA-YOTSU style was significantly greater than those of AI-YOTSU style. However study was conducted in Japan where judo players more used in KENKA-YOTSU grip style whereas Indian judo players more using AI-YOTSU grip style.⁴

The ACL injury occurrence when being attacked was not significantly greater than when being counter attacked. In the 32 dominant ACL injury 11 injuries produced while attempting an attack and 21 ACL injuries produced while being attacked, in 7 non dominant ACL injuries, 2 ACL injury occurred while attempting an attack where as 5 ACL injuries occurred while being attacked. A total of 26 injuries out of 39 injuries reported during participants while being attacked. There was no statistical association between judokas behavior on dominant and non dominant leg injuries. ($P>.571$) This was in accordance with study done by S Koshida *et al*. In their study out of 43 injuries 29 injuries occurred due to being attacked .8 injuries being counter attacked and 6 injuries have occurred while attempting an attack. The participant attempt to throw the opponent by breaking the opponent's balance forward and placing their leg in front of the opponent's leg to make him/her trip on it forwards. In the event of ACL injury, valgus stress may have been applied to the participant's knee of the leg placed in direct contact on the lateral side.⁴ Direct

contact technique was significantly greater than the indirect technique ($X^2=29.64, p<.0001$).

In the 32 dominant ACL injury 31 injuries occurred due to direct injury and 1 ACL injury occurred due to indirect injury, In 7 non dominant ACL injuries 6 ACL injuries occurred as direct injury where as 1 ACL injury occurred as indirect. There was no statistical association between technique which caused ACL injuries on dominant and non dominant leg injuries ($p>.331$). This was in accordance with study done by S Koshida *et al* which showed that out of 43 ACL injuries occurred 36 cases of direct contact injury whereas 7 cases of indirect injury. No non contact injury was observed in investigation. In the preparatory phase of the throw, the centre of mass of a judoka who is attacked needs to be moved in a medial-lateral direction, resulting in a shift of body weight to one leg.¹⁸ 19 Simultaneously, the judoka who attacks needs to place his body properly for a successful throw.¹⁹ In the case of ACL injury incidents, we speculate that the valgus stress and then the rotational force applied to the participant's leg by the opponent's action in the throwing phase (probably due to the poor skill of balance breaking and/or misplaced body position of the opponent during the preparatory phase) were causative factors.⁴

With regard to ACL injury occurrence in team sports such as basketball, soccer and team Handball, a number of studies have reported that the majority of ACL injuries occurred in noncontact Situations such as in-cutting, stopping and jump landing. However in this injuries were more due to non contact mechanism. This clearly shows that in judo ACL injuries are more common during direct contact mechanism. However there are some limitations we found in this study like, since the study conducted respectively, the reliability of the participant responses to the questionnaire and the interview warrants careful consideration. A larger sample size of specific group need to be investigated. Level of category that could have influence the study.

Further recommendations for future research work, like A larger sample size may help us to fully describe the common mechanisms of ACL Injuries in judo, It may be necessary to develop an ACL injury awareness programme specifically for judo and this education programme may also help judokas recognize and avoid situations of high risk for ACL injury in judo. The difference in gender or other individual characteristics may also need to be taken into consideration in developing an effective preventive strategy for ACL injury in judo. There exists a need to find out the other knee injury such as PCL injury, meniscal injury occurring among judo players. To find out the effectiveness of strengthening exercise in preventing the ACL injury can also be done. To find out incidence of ACL injury in fresher's or experienced judo players.

Conclusion

The results show there was no significant difference in grip style, grip side and judokas behaviour on leg dominance in ACL injuries among judo players but there was significant differences with the technique that caused the ACL injury in judo players.

REFERENCES

1. Urho, M. Kujala, Simo Taimela, Ilkka Antti-Poika, Sakari Orava, Risto Tuominen, Pertti Myllyen, 1994. Acute injuries in soccer, ice hockey, volley ball, basketball, judo and karate. *British Medical Journal*. 311:1465-8.
2. B D Chaurasia human anatomy, lower limb abdomen and pelvis 6th edition vol 2 .
3. Don Johnson ACL made simple 5th edition
4. Koshida, S., Deguchi, T., Miyashita, K., Iwai, K., Urabe, Y. 2010. Common mechanism of anterior cruciate ligament injury in judo a retrospective analysis. *British journal of sports Medicine*. 44:856-861.
5. Myklebust, G., Maehium, S., Engebretsen, L., et al. 1997. Registration of cruciate ligament injuries in Norwegian top level team handball: *Scand J. Med. Sci. Sports.*, 7:289-92.
6. Kevin, R. Ford, Gregory, D. Myer, Harrison E. Toms, and Timothy E. Hewet. 2005. Gender differences in the kinematics of unanticipated cutting in young athletes. *Medical Science Sports Exercise*; 37:124-129.
7. Tetsuya Onda, Kei Asou, Seiji Aruga, Yutaka Nakamura, Tamotu Terao, Hidetoshi Nakanishi and Hideo 2004. Matsumotothe body composition of women students judo players. *Tokai Journal of Sports Medicine*; 16:45-53.
8. Tetsuya Onda, Seiji Aruga, Tamotsu Terao, Yutaka Nakamura, Seiji Miyazaki, Nobuyuki Sato and Takehisa Iwakawa. Conducted a study on injuries in university judo players. *Tokai journal of sports medicine. Science*; 11:44-51.
9. Seiji Miyazaki, Yutaka Nakamura, Nobuyuki Satou, Toshiaki Hashimoto, Hideharu Shirase, Yasuhiro Yamashita, Hidetoshi Nakanishi and Kenichirou Uemizu. The influence of anterior cruciate ligament injury for meinscal injuries of judo athletes. *Tokai journal of sports medicine* 2007; 19:75-78.
10. Green, C.M., Petrou, M.J., Fogarty-Hover, M.L., Rolf, C.G. Injuries among judokas during competition. *Journal of Med. Sci. Sports*. Jun; 17(3):205-10.
11. Seiji Aruga, Hidetoshi Nakanishi, Yasuhiro Yamashita, Tetsuya Onda and Ken Ubukata. 2005. A study on the training method for improving judo player's athletic ability with regard to their lower body using the single leg hoping method. *Tokai Journal of Sports Medicine. Science*, 17:7-15.
12. Robert Brophy, Holly Jacinnda Silvers, Tyler Gonzales, Bert R Mandelbaum. 2010. Gender influences, the role of leg dominance ACL injury among soccer players. *British Journal of Sports Medicine*, 44:694-697.
13. Ettlinger, C.F., Johnson, R.J., Shaly, J.E. 1995. A method to help reduce the risk of serious knee sprains incurred in an alpine skiing, *Am. J. sport. Med.*, 23:531-7
14. Tetsuya Onda, Seiji Aruga, Yutaka Nakamura, Tamotsu Terao, Seiji Miyazaki, Hideharu Shirase, Hidetoshi Nakanishi and Takehisa Iwakawa. 2004. The study on the changing of body composition of women students' judo players. *Tokai journal of sports medicine. Science* ; 14:41-47.
15. O O Jibuike, G Paul Taylor, S. Maulavi, P, Richmond, J. 2003. Fairclough Managment of soft tissue knee injury in an accident and emergency department:the effect of the introduction of the physiotherapy *practitioner emergency med Journal*; 20:37-39
16. O.E Olsen, G. Myklebust, L. Engebretsen, I. Holme, R. Bahr Relationship between floor type and risk of ACL injury in team handball *Journal of medical science and sports.*, 3:299-304.
17. Zmago Krajnc, Matjaz Vogrin, Gregor Recnik, Anton Crnjac, Matej Drobnic, Vane Antolic increased risk of knee injuries and osteoarthritis in the non-dominant leg of former professional football players. *The middle European Journal of Medicine*, 122:40-43
18. Yutaka Nakamura, Tamatu Terao Masaru Saito, Taisuke Tomato, Seji Miyazaki, and Yoshiyasu Uthiyama effects of anteriot instability of knee on physical activities in judo players *Tokai Journal of Sports Medicine*, 16:45-53.
19. Seiji Aruga, Koji Shibamoto, Hidetoshi Nakanishi, Yasuhiro Yamashita, Hideharu Shirase, Tetsuya Onda, Kei Aso and Ken Ubukata. 2004. Single leg squat in judo players. *Tokai journal of sports medicine. Science*, 16;34-44
20. Tetsuya Onda, Seiji Aruga, Yutaka Nakamura, Tamotsu Terao, Seiji Miyazaki, Hideharu Shirase, Hidetoshi Nakanishi and Takehisa Iwakawa. 2004. Changing of body composition of women students judo players *Tokai journal of sports medicine. Science*, 14;41-47
