Analysis of Taekwondo Performance in Relation to Selected Anthropometric Measurements

A

Synopsis

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INTRODUCTION

Taekwondo is a Korean martial art, characterized by its emphasis on head-height kicks, jumping and spinning kicks, and fast kicking techniques. taekwondo is a Korean word in which "Tae" means foot or kick, "Kwon" means fist or punch and "Do" means way of or an art or method. So, literally Taekwondo means "the way of the foot and fist" or we can say "the method or art of kicking and punching". The name taekwondo was officially adopted for this martial art in 1955 after that name had been submitted by the South Korean general Choi Hong-Hi, the principal founder of Taekwondo. Since 1955, the name taekwondo comes into existence whereas the evolution of taekwondo is the result of happenings in korea about 2,300 years ago.

Taekwondo is being practiced in more than 140 countries in the globe and 120 countries are officially affiliated to its organisation 'World Taekwondo Federation' (WTF). Taekwondo was demonstrated as a sport in the 1988 and 1992 Olympic games. Then in 2000 Olympic games at Sydney, it was included as an Olympic sport officially. Kyorugi is a full-contact sparring which had been an Olympic event since Sydney Olympic Games in the year 2000.

In taekwondo, non-slippery mats are used for the competition arena. There are two types of competition arenas that are being used in national and international competitions. The first one is square-shaped and the other one is octagonal shaped. The competition area is of 12m x 12m in which allowed contest area is of 8m x 8m and remaining 4m x 4m is for safety area

There shall be three rounds of two minutes , with a one-minute rest period between rounds. After the completion of third round, if the score of players tie then another round will be conducted which is of one minute for the Golden Point. In that round, the first player to score valid point shall be declared as the winner.

Permitted techniques i.e. Fist technique in which a straight punching technique using the knuckle part of a tightly clenched fist. And the other one is foot technique which is a delivering techniques using any part of the foot below the ankle bone.

Permitted areas in competition are as follows:-

Trunk: Attack by fist and foot techniques on the areas covered by the trunk protector are permitted. However, such attacks shall not be made on the part of the spine.

Head: The area above the collar bone. Only foot techniques are permitted.

The valid scores in taekwondo are as follows:-

1. A valid punch to the trunk area will be awarded one point.
2. A valid kick to the trunk area will be awarded two points
3. A valid turning kick to the trunk area will be awarded three points.
4. A valid kick to the head will be awarded three points
5. A valid turning kick to the head will be awarded four points.

There are few prohibited acts and penalties which shall be declared by the referee for which "Gam-jeom" shall be given to the player. If a player gets ten gam-jeom, the refree shall declare the player loser by referee's punitive declaration (PUN).

INTRODUCTION TO ANTHROPOMETRY

Anthropometry is derived from two Greek words Anthropos means "human", and metron, means to "measure" it refers to the measurement of the human individual. Anthropometry is a systematic and scientific measurement of the human body. Anthropometric measurements includes the size, shape, structure and composition i.e height, weight, surface area, volume, shoulder/hip width, arm/leg length, circumferences, percentage of body fat, water content and lean body mass of humans. Anthropometry was developed as a method employed by anthropologists for the study of variations in humans and evolution of populations in both living and extinct.

Alphonse Bertillon founded the Society of Anthropology of Paris. The classification system known as the "anthropometric system" or "judicial anthropometry" was developed by Alphonse Bertillon for which he is remembered as the father of anthropometrics. In the beginning ,Alphonse Bertillon worked for the Paris police force in the department of criminal records. At that time, the criminal records were stored alphabetically which created more difficulty in identifying the repeat offenders. For this problem, Bertillon developed a new classification system which was based on anthropomorphic measurements. Bertillon obtained different anthropometric measurements to distinguish characteristics of criminals

in custody. He then differentiated each individual as small, medium, or large, and added frontal and profile photography to each file. Such photography is still currently used today in the form of a “mug shot”.

Relationship of taekwondo performance with anthropometry

As mentioned earlier, the scoring in taekwondo varies depending upon the part of the body being hit by the kick performed and the type of kick being performed by the player. Maximum points are awarded to the kick being hit to the head (any turning kick to head is awarded with 4 points and any simple valid kick to the head is awarded with 3 points). Thus a player having longer leg length may have an advantage in scoring head kicks easily and acquiring maximum scores.

Also having longer legs may also helpful to cover more range during the kick rather than a player who is having shorter legs have to give his extra efforts to cover the area or required range in between him and his opponent while kicking.

One study was given by Suwat Sidthilaw (1996) and in which he determine kinetic and kinematic characteristics of Thai Boxing Roundhouse Kick. The kicking trials were conducted at three height levels to measure the kinetic variables of peak force and impulse. Based on the results of this study and with awareness of its limitations several conclusions were drawn. In comparing the roundhouse kick at different height levels the middle level kick generated the greatest peak force and impulse, and the high level kick generated the least amount of peak force and impulse. Take for instance two players one having taller height and one having shorter height. The head of opponent for taller height player is at middle level and for shorter height player it is at high level. Thus the player having taller height have more chances of knocking out his shorter height opponent.
Also various studies were conducted on body composition of taekwondo players and most of their results shows that an average elite taekwondo players possess very low fat percentage in their body.

Many other related studies suggests that there may be a significant relation between the various anthropometric variables and the performances of the Taekwondo players.

Objective of the study

The objectives of the study is to analyse the relationship between selected anthropometric variables with the winning performance of players.

Statement of the problem

The statement of the problem is analysis of Taekwondo Performance in Relation to Selected Anthropometric Measurements.

Research questions

1) Is there any relationship between the anthropometric measurements with the performance of Taekwondo player?
2) Whether there is any advantage for taller players in taekwondo *Kyorugi* competitions?
3) Does body composition affect the performance of taekwondo players?
4) Whether having longer legs of players increases the chances of better performance?

Hypotheses

Based on expert's opinion, reviews and scholar's own understanding of the problem & research findings it is hypothesized that there will be significant relation between selected anthropometric measurements with the winning performance of taekwondo players.

Delimitations

1. This study will be delimited to male subjects from Senior National level players.
2. The study will be delimited to fin (under 54 kg) weight category only.
3. All the measurements will be calculated by the same researcher using the same tools for every subject.
4. The study will be delimited to following anthropometric variables:-
   a) Standing Height
   b) Sitting Height
   c) Lower Limb length
   d) Pelvic joint to knee joint length
   e) Knee joint to ankle length

f) Weight

g) Biepicondylar Width of the Femur

h) Bi-iliocristal Width

i) Girths of flexed calf and thigh

j) Body Mass Index

k) Skin Fold Thickness(3 site)

Limitations

The tools used for calculating the measurements might influence the results of the study.

- The diet, health habits, living standard, rest, injuries, daily routines and lifestyle of individual athlete is different and can't be controlled.
- The final limitations will be asses after completion of the study and during data collection.

Operational Definition of the terms

- **Taekwondo:-** Taekwon-do is a Korean unarmed martial art. It is not only kicking and punching, but a way of thinking and living. The main goal of Taekwon-do is to achieve total mind and body control through training. "Tae" means foot, "Kwon" means fist, and "Do" means the way of, so Taekwondo literally means "The way of the foot and fist**." (www.grtkd.com)**

- **Kyorugi:-** kyorugi means not only sparring but also a sort of real fighting. But in most cases it means the sparring or competition. **(www.taekwondobible.com)**

- **Anthropometry:-** Anthropometry is the science which deals with the measurement of the size, weight, and proportions of the human body. **(Dorland's Medical Dictionary)**

- **Standing height:-** standing height is the measurement the maximum distance from the floor to the highest point of the head, when the subject is facing directly ahead. Shoes should be off, feet together, and arms by the sides. Heels, buttocks and upper back should also be in contact with the wall when the measurement is made. (www.topendsports.com)

- **Sitting height:-** Sitting height gives a measure of the length of the trunk. It is a measurement of the distance from the highest point on the head to the base sitting surface. (www.topendsports.com)
- **Weight:w**eight is the force due to the effect of gravity on body mass, expressed in new ton. (www.thefreedictionary.com)
- **Biepicondylar Width:-** The maximum distance between lateral and medial epicondyles of the femur which is measured with the help of sliding caliper.
- **Iliac Height:-** The height from the widest edge of the iliac crest to the level of floor is termed as iliac height.
- **Knee Height:-** The height from the sole of the foot to the upper part of the patella is termed as knee heigt.

Significance of the study

Today, Taekwondo has become a global sport that has gained an international reputation and stands among the official games in the Olympics. Taekwondo is rapidly growing martial art in the world and day by day becoming more famous sport among the youth and elders. The research in this field will be very significant in the following ways:-

1. This study may helpful for the coaches and selectors in talent identification of players, in future who may bring medals for state and country.
2. This study may help the beginners to whether choose or not to choose taekwondo as their future career.
3. This study may help the coaches to prepare different effective training programs for taekwondo players having different anthropometric measurements.
4. This study may also guide the players to attain required physical components for better performance in the taekwondo competitions.

REVIEW OF RELATED LITERATURE

The research scholar has attempted to locate some of the literature related to the study. The relevant literature found from various sources are cited below-

Heller et al. (1998) constructed a study on the topic entitled as "Physiological profiles of male and female taekwondo (ITF) black belts." The data were collected for 11 male and 12 female elite taekwondo athletes from the Czech national team. The variables slescted were anthropometry measurements, , strength, visual reaction time, pulmonary function, aerobic and anaerobic capacities, flexibility and explosive power of the lower limbs. Anthropometric variables were body height, mass, circumferences, diameters and 10 skinfold measurements to determine body fat and lean body mass. In addition, bioelectrical impedance analysis of body composition was also performed (Bunc and Dlouha , 1993, 1995). The results showed that both male and female taekwondo black belts demonstrated extremely low estimated body fat percentages, increased amounts of lean body mass, above-average values of muscle strength, flexibility, PWC-170, and aerobic and anaerobic capacity.

Kazemi et al. (2004) conducted the comparative study on "2004 Olympic Tae Kwon Do Athlete Profile". The main aim of his study was to identify the characteristics of Taekwondo champions (gold, silver, and bronze medalists) who participated in the Athens 2004 Olympic Games (N = 124) and compared them to those who competed but did not earn medals. The data obtained for the study was taken from the official website of the 2004 Olympic Games www.athens2004.com. The information collected from the website were: weight category, weight, height, age, country representation, total points from kicks per weight category, total points from punches per weight category, total penalties per weight category, and type of win. STATA was used for analyse the information. Variables were labelled by coding. Then this descriptive statistics were calculated for each athlete according to gender: age, height, weight, and body mass index (BMI). No statistically significant differences exist between winners and non-winners with respect to age, height, weight and gender. This study investigated 124 Taekwondo athletes who competed in the 2004 Olympic Games. The results suggested that winners were slightly taller and had a slightly lower BMI than non-winners; however, these were not statistically significant. Overall, kicking was the main technique used to score points in the competition. Specifically, one point offensive kicks were used to score the maximum points, followed by defensive kicks, and offensive

two-point kicks. The number of kyong-go and gam-jeom were increased in the 2004 Olympic Games compared to that in 2000 Olympic Games, which may suggest more aggressive fighting style in the 2004 Olympic Games.

Kazemi et al. (2006) studied and developed "a profile of olympic taekwondo competitors". The aim of his study was to identify the profile of the Olympic champions and the other competitors who were involved in the Games. Official website of the Sydney 2000 Olympic Games was used to obtain the information which included weight category, weight, height, age, points obtained, warnings, deduction point, defensive/offensive kicks and punches. 102 athletes competed (54 males and 48 females) in the Games. The mean average age and BMI (Body Mass Index) of 16 male winners was compared to 38 male non-winners. Descriptive statistics were used for the calculations. Analyses of variance were used to compare differences between demographic characteristics and techniques used to score. The level of significance was set at $p = 0.05$. A variable (rank) was created based on performance outcome (1=gold, 2=silver, 3=bronze, 4=bronze 5=no medal) in order to examine relationships between the demographic and technique variables. This study examined 102 athletes who competed in the Sydney 2000 Olympic Games. The results suggested that the winners were younger in age and taller with slightly lower BMI than their weight category average. In general, an offensive technique was used to score slightly more often than a defensive one.

Kazemi et al. (2010) reviewed and performed a comparative study on "A profile of 2008 Olympic Taekwondo competitors". The aim of his study was to identify the characteristics of Olympic medal winners (gold, silver, bronze) who competed in the 2008 Beijing Olympic Games to those who competed but did not won medals. They have also descriptively analysed the 2008 data in comparison to the 2004 data (Kazemi et al., 2009), and 2000 data (Kazemi et al., 2006) and summarized changes that were identified. The data for this study was obtained from the official 2008 Olympic website, http://en.beijing2008.cn/ a public domain website. The information obtained from this website includes the following: participant's weight, height, date of birth, country, round report, points obtained, warnings (kyong-go, gam-jeom), deduction points, type of score (defensive kicks, offensive kicks, offensive and defensive punches), list of referee and judges with country origin. T - tests were used to compare winners versus non winners stratified by gender in terms of age, height, weight and BMI. Chi-squared statistical technique was used for analysis of data.

Statistical analysis was conducted using the STATA version 10 software. Variables were coded and labelled prior to analysis. The result was not statistical significant but male winners were slightly older, taller, with lower BMIs as compared to non-winners. Female winners were slightly younger, shorter, with greater BMI's as compared to non-winners. There was a significant decrease in frequency of warnings from 2004 to 2008. Unlike 2004, the 2008 Olympic Taekwondo competitors used more defensive kicks to score. These suggest a shift from aggressive tactics to score to a more conservative one.

Ghorbanzadeh et al. (2011) conducted the research on "Determination of Taekwondo National Team Selection Criterions by Measuring Physical and Physiological Parameters". The purpose of his study was to establish the physical and physiological attributes of elite and sub elite Turkish male and female taekwondo players and to determine whether these attributes discriminate elite players from sub-elite players. Measurements and tests of basic anthropometry (standing and sitting height, BMI, biepicondylar widths of the humerus and femur, biacromial and bi-iliocristal widths, girths of the flexed and tensed biceps, calf, thigh, chest, hip, abdomen and shoulder), explosive power, anaerobic recovery capacity arm strength, were conducted on two occasions, separated by at least one day. The research has been carried out with 24 men and 16 women successful Turkish National Team taekwondo athletes who have had degrees in European and World Championships several times, and 24 male and 16 female ordinary athletes who have not been in National Teams. 81 subjects have taken part in this research. In the research, totally 31 physical and anthropometric variables have been analysed by testing. In comparing the data obtaining from the athletes who were and were not in National Teams in free group, 't' test; and as for determining the statistical relations between the anthropometric and physical characteristics, Pearson Correlation analyze statistics has been used. In analyzing the results, the significance level has been accepted as ($p<0.05$). The result of the research indicates that national team athletes are superior to those who are not in the national team in terms of anaerobic power, arm strength and height. The result of the research also indicates that age for sports is an important factor in getting into a national team. Because athletes who manage to get into The National Team have higher levels of age for sports when they are compared to the rest of the group and those who cannot get into the national team.

Giampietro et al. (2003) performed their study on "Anthropometric features and body composition of young athletes performing karate at high and medium competitive

level". he aim of the study was to examine the anthropometric features and body composition of athletes practising karate at a high and medium competitive level. Our study was carried out on a sample of 35 subjects practising karate and aged from 16.0 to 32.5 years. This sample was divided into two groups: group 1 (n=14 elite athletes) and group 2 (n=21 amateur athletes). Various anthropometric measurements were taken (weight, height both standing and sitting, diameters, circumferences and skinfold thickness) from which different anthropometric indices were calculated (body mass index, Scelic and Grant indices, arm muscle circumference and area), and the somatotype was then determined. The body composition of each subject was assessed using the skinfold technique and the Jackson-Pollock (J-P) and Sloan-Weir (S-W) equations. The two groups of athletes showed very similar measurements regarding anthropometric characteristics. Only the Scelix index presented a significantly different value in the two groups (49.6+/-1.3 for group 1 vs. 51.1+/-1.3 for group 2; $p<0.01$). Group 1 showed a mesomorphic-ectomorphic somatotype, while the amateur athletes presented a balanced mesomorphic type. Moreover, a lower percentage of fat mass was more frequent in the first group (J-P=8.1+/-2.4%; S-W=8.9+/-3.3%) than in the second one (J-P=9.8+/-1.6%; S-W=11.2+/-3.7%), although the differences between the two groups were not significant. We conclude that group 1 is characterized by a slightly prominent vertical development of the skeletal frame. This could be an anthropometric characteristic that is best suited to meet the specific functional requirements of this sport. Moreover, both groups of athletes are characterized by a low percentage of fat mass, particularly the elite group.

ARAZI et al. (2016) conducted the research on relationship between anthropometric, physiological and physical characteristics with success of female taekwondo athletes. The aim of this study was to investigate the relationship between various variables with the success of elite female taekwondo athletes. Forty subjects were selected from elite female taekwondo athletes who won medals in regional and national championships. All subjects were assessed for height, weight, lengths, girths, body mass index, waist-to-hip ratio and skin-fold thickness. Percentage of body fat was calculated from the sum of 3 site measurements of skin-fold thickness. Aerobic and anaerobic power were also calculated using by cooper and Sargent vertical jump tests respectively and then by placing into the standard recommended equations. Speed, agility, muscular endurance and flexibility were assessed using by 36m sprint, 4×9m shuttle run, push-ups and sit-and reach tests respectively. The normal distribution of data was determined through Kolmogrov-Smirnov test and the Pearson correlation coefficient was used to determine the relationship

between anthropometric, physiological and physical characteristics with success. All statistical analyses were performed using SPSS version 20. P<0.05 was considered statistically significant. The results showed that from all of the anthropometric, physiological and physical characteristics were assessed in this study, anaerobic and aerobic power, body mass index and fat percentage, speed and agility have more importance in success of taekwondo athletes.

Estevan et al. (2012) conducted an experimental study on "Effect of Olympic Weight Category on Performance in the Roundhouse Kick to the Head in Taekwondo". This study aimed to analyse performance in the roundhouse kick to the head according to execution distance between and within Olympic weight categories. The participants were 36 male athletes divided into three categories: featherweight (n = 10), welterweight (n = 15) and heavyweight (n = 11). A new adaptation of the model created by Falco et al. (2009) was used in the present study to measure the mechanical variables. The adapted model allows measurement of longer time periods of the kick and a larger range of force with similar reliability to the original model. Statistical analyses were performed using the SPSS 15.0 computer package. All parameters were normally distributed (Kolmogorov–Smirnov test). The intraclass correlation coefficient (ICC) for mechanical variables was determined. Values of mechanical variables were normalized (z-score) to compare data between groups according to the Olympic category. A mixed ANOVA model was used to compare mechanical variables between execution distances in the same Olympic category; pairwise comparisons were performed using Bonferroni statistics. Cohen's d score was quantified to analyse the effect size (Cohen, 1988). The statistical significance was set at $p < 0.05$. The results indicate that weight has a large impact on kick performance, particularly in relation to total response time.

Paul (2015) performed "A Comparative Study of Speed Reaction Time and its Relation with Some Selected Anthropometrical Measures of Active and Sedentary College Student". The purpose of the study was to compare one such coordinative component with some anthropometric measures of active and sedentary college student. The measured criteria were the speed reaction time, standing height, sitting height and lower limb length. The mean of Speed reaction time (sec.), Standing Height (cm.), Sitting Height (cm.) and Lower Limb Length (cm.) of active and sedentary group were 7.91, 153.33, 73.22, 76.22 and 9.16, 157.75, 77.74, 79.01 respectively. Fourty students were taken as the subjects of

this study. Among them 20 were active that took part in regular exercise and 20 were sedentary, never engaged in activity. The active students were taken from the State Institute of Physical Education for Women, Hastings House, Alipur, Kolkata and the rest 20 were taken from Surendranath College, Barracpore, 24pgs.(N). The subjects were selected randomly. The measured criteria were the Speed reaction time by 50 mtr. dash, Standing height (in cm.), Sitting height (in cm.) and Lower Limb Length (in cm.). No such conclusions can be drawn from the findings. Although the co-rrelations were negative but the values were too low to draw any definite conclusions. Generally it may be concluded that the lower limb length hinders the speed reaction time performance.

Abidin et al. (2013) conducted the study on "Prediction of Vertical Jump Height from Anthropometric Factors in Male and Female Martial Arts Athletes". Vertical jump is an index representing leg/kick power. The explosive movement of the kick is the key to scoring in martial arts competitions. The objective of the study was to identify anthropometric factors that influence vertical jump height for male and female martial arts athletes. Twenty-nine male and 25 female athletes participated in this study. The athletes involved in this study were martial arts athletes who participated in the 2008 Asian University Games. The participants were from Silat, Taekwondo and Karate do fields. Participants were athletes who had won a medal at the national level in the previous year and were Malaysian undergraduate students whose ages ranged from 18 to 24 years old. Their heights were measured using a stadiometer. The subjects were weighted using digital scale. Body mass index was calculated by kg/m2. Waist–hip ratio was measured from the ratio of waist to hip circumferences. Body fat % was obtained from the sum of four skinfold thickness using Harpenden callipers. The highest vertical jump from a stationary standing position was recorded. The maximum grip was recorded using a dynamometer. For standing back strength, the maximum pull upwards using a handle bar was recorded. Multiple linear regression was used to obtain the relationship between vertical jump height and explanatory variables with gender effect. The results showed that body size, body height, grip strength and standing back strength do not significantly contribute to the vertical jump height of martial arts athletes. In contrast, body fat % is an anthropometrical factor that has a significant negative relationship with vertical jump height of martial arts athletes. Reducing the amount of body fat with proper physical training and dietary planning will be helpful to improve the leg power or the kicks.

Santos et al. (2011) reviewed "Relationship between attack and skipping in Taekwondo contests". The purpose of this study was to determine the relationship between attack time (AT) and skipping time (ST) during the 2007 Taekwondo World Championship and 2008 Beijing Olympic Games. A total of 22 matches (65 rounds, 13 semi finals, and 8 finals) from the World Championship and 23 matches (63 rounds, 22 rounds with 16 athletes each and 1 quarterfinal round) from the Olympic Games, both in the male category, were assessed using time–motion analysis. The AT was considered as the total time during which the athlete attacked or tried to attack, whereas ST was the total time without attempting to attack. The ratio of AT to ST was ;1:7 based on the data pooled from the 2 competitions. The AT/ST ratio was significantly lower for the World Championship than for the Olympic Games (p # 0.05). In the Olympic Games, no consistent differences across weight divisions were found. However, during the World Championship, the heavier weight divisions (.78 kg) exhibited a lower average AT, lower summed AT, lower attack numbers (ANs)and higher average ST than lighter weight divisions (,58 kg, p # 0.05). For both competitions, the ST was lower, and the ANs and AT/ST ratio were higher in round 3 than in round 1 or 2. In conclusion, the results of this study suggest that matches in the Olympic Games were less cadenced than in the World Championship, but that in both competitions, the intensity of the match increased in round 3.

Sidthilaw (1996) conducted the study for the degree of Doctor of Philosophy in Human Performance which was titled as "Kinetic and Kinematic Analysis of Thai Boxing Roundhouse Kicks". The purpose of this study was to determine kinetic and kinematic characteristics of Thai Boxing Roundhouse Kicks. In order to measure the kinetic variables of peak force and impulse, a triaxial accelerometer was inserted into a kicking bag. The force data were derived from the known mass and measured acceleration of the kicking bag. Validation testing comparing applied forces to estimated forces based on accelerometers output showed this instrument provided accurate estimates of the force applied to the kicking bag (r = .99). The MacReflex motion analysis system was utilized with three cameras operating at 120 frames per second to obtain the kinematic characteristics of final linear velocity of the kicking ankle, linear velocity of the kicking ankle and knee, angular velocity of the knee, and the angular velocity of the shank and thigh projected onto the horizontal plane. The subjects were ten male Thai Boxing performers with 8 to 48 months of training experience. The kicking trials were conducted at three height levels. It was hypothesized that the peak force, impulse, and the final linear velocity of the kicking ankle at impact would be greater for the lower level of kicks as compared to the higher level of kicks. It was also

hypothesized that peak force and impulse would be positively related the subjects' leg strength. For the relationship between kinetic variables and kinematic variables it was hypothesized that peak force and impulse would be positively related to the final linear velocity of the kicking ankle. In comparing the round house kick at different height levels the middle level kick generated the greatest peak force and impulse, while the high level kick involved the least force and impulse. The amount of peak force and impulse were directly related to the final velocity of the ankle (r = .86, and r = .79 respectively), but they were not significantly related to the leg strength.

Tabben et al. (2014) conducted the study "Physical and physiological characteristics of high-level combat sport athletes". This study attempted to establish physical and physiological characteristics of different high-level combat sport athletes (judo, karate, and taekwondo) and to determine possible differences between these athletes. Fifty-four elite judo (n = 19), karate (n = 19) and taekwondo (n = 16) athletes took part in the present study. The experimental design consisted of two test sessions. On the first one, athletes performed the squat jump (SJ), countermovement jump (CMJ), and a maximal treadmill test to determine O2max. The second session included the five jump test (5JT), 30m sprint, and one repetition-maximum (1RM) during three exercises: bench-press, half-squat and lying row. Data are presented as mean ± standard deviation for para- metric data and median and percentiles 25th and 75th for nonparametric data. The Levene test was used to verify the homogeneity of variances for each variable analyzed. An one way analysis of variance was used to compare combat sport groups for each variable. The Tukey test was used for post-hoc comparisons. For half-squat 1RM test, O2max, and VO2max, the test of homogeneity of variances assumption was violated and the Kruskal-Wallis test was used, followed by a Mann Whitney test. Effect sizes were calculated using partial eta-squared. Significance level was set at 5%. The main finding of the present study was that high level judo, karate and taekwondo athletes tested before a continental event had different physical characteristics. Concerning lower-limb muscle power, this study demonstrated that 5JT, SJ, and CMJ performances were higher in karate athletes compared to judo and taekwondo athletes. Although these features of karate are also observed in taekwondo, this study showed that SJ, CMJ, and 5JT performances were lower in taekwondo athletes than karate athletes. This difference is difficult to explain because it has been reported that taekwondo athletes use kicks more frequently during a match than karate players. The difference between karate and taekwondo athletes during the SJ, CMJ, and 5JT may be a consequence of the frequent use of kicks by the taekwondo athletes. In fact, much emphasis is placed on lower-limb power

generation, which is necessary to generate powerful kicks in taekwondo [17]. This emphasis on kicks could result in a better lower limb endurance rather than power development.

Thakur et al. (2017) performed a comparative study on "Relationship of agility and speed ability with selected anthropometric variables of male football players". The purpose of the study was to examine the relationship of agility and speed ability with selected anthropometric variables of male football players. For the purpose of the study 30 male football players were randomly selected from Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.) and those players who represented this Vishwavidyalaya at inter university tournament. The age group of the subjects was ranged from 21-28 years. The data was collected through applying the tests: 10x4 meter shuttle run test for agility ability, 50 meter dash run test for speed ability and selected anthropometric variables: body weight, standing height, leg length, thigh girth and calf girth. For the relationship of agility and speed ability with selected anthropometric variables mean and standard deviation were used as descriptive statistics and Pearson Product Moment coefficient test were applied at 0.05 level of significant. All statistical analysis was done using MS Excel and SPSS version 16.0. The result of the present study showed that there was Significant relationship found in selected anthropometric variables (height- r=.384, $p<0.05$; weight- r=.451, $p<0.05$; and leg length- r=.371, $p<0.05$) and insignificant relationship found in thigh girth (r=.332) and calf girth (.353) of Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G) in relation to agility ability. There was significant relationship found in selected anthropometric variables (height- r=.365, $p<0.05$; weight- r=.378, $p<0.05$; leg length- r=.392, $p<0.05$; and thigh girth r=.370, $p<0.05$) and insignificant relationship found in calf girth (r=.231) of Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G) in relation to speed ability.

Dhapola et al. (2017) conducted the correlational study on "Relationship of body mass index with agility and speed of university players". The aim of this study was to investigate the relationships of height, weight and BMI with agility and speed of male university players. A total of 46 male University players (from Cricket, Football, Hockey and Handball) were selected from the Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh. Age of the players was ranging between 20 to 25 years. Selected Variables for the study were Height, Weight, BMI, Agility and Speed. Standardized test or tools like stadiometer, weighing machine, 4x10mt. Shuttle run test, 50 yard dash test etc. were used to collect the data for selected variables. To find out relationship between selected variables, descriptive statistics and the Pearson's Product Moment Correlation was used. The results showed that there exists a significant relationship between Weight and Agility (r=.670,

p<0.05), weight and speed (r=.543, p<0.05), BMI and Agility (r=.546, p<0.05) and BMI and Speed (r=.752, p<0.05). There were no significant correlation found between Height and Agility (r=.164, p>0.05) and Height and Speed (r=.065, p>0.05).

Ferreira et al. (2017) performed a cross-sectional association study having title "Relationship between frequency speed of kick test performance, optimal load, and anthropometric variables in black-belt taekwondo athletes". The purpose of this study was to verify the relationship between frequency speed of kick test (FSKT) performance, optimal load, and anthropometric characteristics in taekwondo athletes. Sixteen black-belt taekwondo athletes volunteered to participate in the study. FSKT performance with durations of 10s and 90s, optimal load in jump squat and bench throw, and anthropometric characteristics were measured including somatotype. Data are presented as M, SD, and 95% confidence interval (95% CI). The Shapiro-Wilk test was used to assess data normality. Correlations were carried out using Spearman's correlation coefficients, calculated to examine the relationships between dependent (i.e., FSKT outcomes) and independent variables (i.e., anthropometric data and performance tests). ANOVA one-way with repeated measures was used to check the differences between FSKT series, followed by the Bonferroni post-hoc test and observed power, which was the mainly test used. Significant correlations were only found between: height and FSKT10s (r_s = -0.53 [large]; p = 0.017), height and FSKT4 (r_s = -0.514 [large]; p = 0.021), and body fat (kg) and FSKT4 (r_s = -0.606 [large]; p = 0.006) which indicates that taller taekwondo athletes can perform a lower number of repetitions in the FSKT, compared to shorter athletes. This may be due to the fact that taller athletes need more time than shorter athletes to go through the space equivalent to the height of the trunk itself. Also Body fat mass was negatively correlated with FSKT4 (r_s = -0.606 [large]; p = 0.006). This result reinforces the statement made previously that it is desirable for athletes to have low percentages of fat to optimize their performance.

MATHUNJWA et al. (2015) conducted the comparative study on "Physical, anthropometric and physiological profiles of experienced junior male and female South African Taekwondo athletes". The research was aimed at identifying the anthropometric, physical and physiological characteristics of junior Taekwondo athletes to achieve an international status. Data were collected from 25 males and 11 females aged 15.5 ±2.6 years. Measurements consisted of body composition (body fat percentage (%BF), sum of 6 skinfolds), flexibility (sit & reach, hip flexor (HF) and quadriceps flexibility (QF), lower extremity explosive power (vertical jump (Diff VJ) and vertical jump relative power (R Power), muscle endurance (sit-ups and push-ups), muscular strength (handgrip right and

left), hexagonal agility (HEX) and agility T-test, aerobic power (20 m bleep test (20MST) converted to maximum oxygen uptake (VO2max.). Data were analyzed using t-test for independent samples and Z-score statistics. The results showed that male Taekwondo athletes tend to have slightly higher body mass and stature than females. No differences in BMI were noted. Statistically significantly higher body fat ($p< 0.001$) and sum of skinfolds ($p<0.05$) were found in junior female athletes compared to males.

Wheeler et al. (2012) performed the study on "Can Anthropometric and Physiological Performance Measures Differentiate between Olympic Selected and Non Selected Taekwondo Athletes?". This study examined whether anthropometric and physiological performance measures differentiate between Olympic selected and non-selected athletes. Height, body mass, skinfold thickness, strength (squat, bench press and bench pull), power (counter-movement jump, single leg counter-movement jump and 20 m sprint) and aerobic performance (shuttle test) from 10 national squad athletes was collected at the selection camp prior to the Olympic Games. Power, velocity and acceleration profiles during bench throw, bench pull and squat jump were also collected using a linear encoder. All data were analysed using PASW (Version 18.0 for Windows). Exploratory analysis demonstrated descriptive statistics were the most appropriate method of data analysis due to the sample size of the current study. Results were reported as mean ± SD as well as the percent difference in Olympic selected athletes compared to non-selected athletes (positive difference meant a greater value for Olympic selected athletes). Anthropometric data showed similar body mass and standing height values for Olympic selected and non-selected athletes (Table 1). Olympic selected athletes had slightly greater overall skinfold thickness compared to non-selected athletes (7.1 %) which was attributed primarily to an increase in front thigh (32.8 %) and calf measures (47.5 %). Despite this, Olympic selected athletes demonstrated a decrease in skinfold thickness at subscapular (-23.9 %) and supraspinale sites (-19.7 %) when compared to the non-selected athletes. The increase in skinfold thickness for Olympic athletes was not reflected in the lean mass index with similar values for both athlete groups.

Dizon et al. (2012) performed the review and correlational study on "Making Filipino Taekwondo Athletes Internationally Competitive: An International Comparison of Anthropometric and Physiologic Characteristics". This research had the objectives of establishing both an anthropometric and physiologic profile of elite Filipino taekwondo athletes and comparing the elite Filipino athletes' anthropometric and physiologic characteristics with published information on other elite athletes and provides useful information regarding components needed to be improved to enhance athletic performance.

A total of twenty elite taekwondo Filipino athletes were assessed in this study. The independent variables chosen for the study were anthropometry measurements, flexibility, agility, maximal strength and power, muscular endurance, sprint and aerobic power. The literature search for international studies identified 32 articles on combat sports which were narrowed down to five (5) studies on taekwondo for comparison. The chosen literature studies for comparison were: Heller et al 1998 (Czech athletes, Kazemi et al 2006 (2000 Olympic winners), Kazemi et al 2006 (2000 Olympic non-winners), Kazemi et al 2009 (2004 Olympic winners), Kazemi et al 2009 (2004 Olympic non -winners). The anthropometric comparisons to other athletes reported in the literature expressed in means, SD and 95% CI. Data collected from the Filipino athletes was analyzed using SAS Version 9.1. The data was described in terms of means and standard errors, or percentages. The Chi square test was used to analyze differences in gender. The results showed that the Filipino male athletes were not different from the other international athletes in age and weight. Body fat levels were not compared as completely different tests were used as measures for this outcome. However, there is a trend towards significance in terms of height comparison with the Filipino male athletes measuring shorter than their counterparts. The elite Filipino female athletes were not different from the other elite female samples reported in the literature in terms of age, height and weight. Varying body fat levels were noted among the groups. However, direct comparisons cannot be made due to the difference in the number of skinfold measures taken to obtained the percentage body fat levels.

Bridge et al. (2014) reviewed computer literature on Physical and Physiological Profiles of Taekwondo Athletes. The themes of the review were selected to represent the major fitness components that are required to support the physical activity and the physiological demands of combat in the context of athlete preparation and performance, including body composition, somatotype, aerobic and anaerobic power, muscular strength, muscular power, flexibility, speed and agility. The researchers reviewed computer literature search of PubMed, ISI Web of Knowledge, Google Scholar, SportDiscus and Scopus was performed for English-language peer-reviewed articles from inception to March 2013 using the following keywords: ‘taekwondo’, ‘taekwondo AND performance’, ‘taekwondo AND physical fitness’, ‘taekwondo AND physiology’, ‘taekwondo AND body composition’, ‘taekwondo AND somatotype’, ‘taekwondo AND aerobic fitness’, ‘taekwondo AND anaerobic fitness’, ‘taekwondo AND strength’, ‘taekwondo AND flexibility’, ‘taekwondo AND speed’ and ‘taekwondo AND agility’. The results showed that international taekwondo athletes possess low levels of body fat and a somatotype that characterises a blend of

moderate musculoskeletal tissue and relative body linearity. While the VO2max of taekwondo athletes is somewhat variable, the available data suggest that moderate to high levels of cardio-respiratory fitness are necessary to support the metabolic demands of fighting and to facilitate recovery between consecutive matches. Taekwondo athletes demonstrate high peak anaerobic power characteristics of the lower limbs and this attribute appears to be conducive to achieving success in international competition. The ability to generate and sustain power output using both concentric and 'stretch-shortening cycle' muscle actions of the lower limbs may be important to support the technical and tactical actions in combat. Taekwondo competitors also display moderate to high maximum dynamic strength characteristics of the lower and upper extremities, and moderate endurance properties of the upper extremity, trunk and hip flexor musculature. The high degree of flexibility displayed in the lower limbs of taekwondo athletes is functionally important to support the technical actions in the sport.

Arabac et al. (2011) performed experimental studies on "Assessment body composition and leg reaction time of elite taekwondo athletes". The main aim of the study was to determine body composition and leg reaction times of elite male taekwondo athletes. Seventeen taekwondo athletes (Mean ± SD; age 21.2±4.7 year, height 173.6±6.5 cm, weight 63.1±10.9 kg, BMI 20.9±2.4 kg/m2) who are doing taekwondo approximately ten years volunteer in present study. Left and right leg reaction time of subjects were measured. Body composition is analyzed with TANITA BC-418MA Segmental Body Analyze Monitor. This device analyzes total body weight, BMI, basal metabolic rate (BMR, kj), body fat (%), fat mass (kg), free fat mass (kg) and total body water (kg). Also, this device analyzes the body both as different regions like left-right legs, left- right arms, trunk (5 different regions) and as total. All statistical analyses were performed using SPSS version 17.0 (SPSS, SPSS Inc, Chicago, IL, USA) software. The mean (±SD), minimum and maximum values of tests were determined. The relationships between leg reaction time (left and right leg separately)and body composition variables were determined by Pearson correlations test. Left and right reaction times of subjects were comparised by Paired-Samples T test. The level of significance was set at 0.05. The mean ± SD BMR, TBF%, TBFM, FFM and TBW of subjects were determined 7260.7±998.8 kj, 7.1±4.1%, 4.8±3.6 kg, 58.4±8.3 kg, and 42.7±6.1 kg, respectively. There was no significant difference between right leg reaction time (291±37 msec) and left leg reaction time (305±38 msec)of subjects ($t=0.873$, $p>0.05$). There was negative significant correlation ($p<0.05$) between a) leg reaction time and leg fat percentage

and b) leg reaction time and leg fat mass. In conclusion, lower leg fat percentages and fat mass of taekwondo athletes affect reaction times in a positive way. Additionally, lower total body fat %, left and right leg fat %, left and right arm fat % and trunk fat % can affect the performances positively.

BORACZYŃSKI et al. (2017) conducted correlational study on "Relationships between anthropometric features, body composition, and anaerobic alactic power in elite post-pubertal and mature male taekwondo athletes". The study aims to find relationships between anthropometric features, body composition, and anaerobic alactic power (AAP) in elite post-pubertal and mature male taekwondo athletes. The sample of 41 taekwondo athletes was divided into two groups: post-pubertal (P-P, n = 19, M_{age} = 15.6 ± 1.1 years) and mature (M, n = 22, M_{age} = 20.7 ± 2.8 years). Anthropometric features (WB-150, ZPU Tryb-Wag, Poland), body composition (BC-418 MA, Tanita, Japan), maturational status (Pubertal Maturational Observational Scale), and AAP (10-s version of the Wingate Anaerobic Test) were assessed. Post-hoc testing revealed significant between-group differences (3.2–20.4%, $p < 0.01$) in all anthropometric and body composition measures, with effect sizes (ES) between −0.79 and −1.25 ($p < 0.001$), except for fat content and percentage of skeletal muscle mass (SMM) (p 0.05). In group M, the maximal power output (P_{max}) was greater (ES = −1.15, $p < 0.001$) and the time of its attainment shorter (ES = 0.59, $p < 0.001$) than in group P-P. Correlation analyses indicated notably strong associations between body mass (BM) and P_{max} in group P-P (r = 0.950 [95% CI, 0.85–0.98], $p < 0.001$) and M (r = 0.926 [95% CI, 0.81–0.97], $p < 0.001$), and similar-sized strong correlations between fat-free mass (FFM) and P_{max} in group P-P (r = 0.955 [95% CI, 0.86–0.99], $p < 0.001$) and M (r = 0.924 [95% CI, 0.82–0.96], $p < 0.001$). Additionally, a strong correlation was found between body height and P_{max} in groups P-P and M (r = 0.805 [95% CI, 0.54–0.92], $p < 0.001$ and r = 0.819 [95% CI, 0.58–0.93], $p < 0.001$, respectively). Linear regression analyses demonstrated that FFM, BM, and absolute SMM best explained the variance in P_{max} in both groups (r, 0.939–0.951; r2 , 0.882–0.909).In summary of all results, strong correlations observed in both groups between body mass, fat free mass, skeletal muscle mass and maximal power demonstrate the significant effects of body size and composition on anaerobic alactic power (AAP). By determining the current levels of these measures for individual athletes and via regressive modelling, one can anticipate the individual developmental dynamics of AAP. On the basis of anthropometric profiling, the

researcher's recommend the recruitment and selection of tall and lean individuals with high anaerobic predisposition in taekwondo.

Arabac et al. (2010) carried out correlational studies on "Relationship between Agility, Speed, Reaction Time and Body Mass Index in Taekwondo Athletes". The purpose of this study was to examine relationship between agility and reaction time, speed and body mass index of taekwondo athletes. Totally, thirty-one female (n=8, age 13.7±1.5 years) and male (n=23, age 14.7±3.9 years), taekwondo athletes volunteered to participate in this study. After 15 min warm-up subjects performed tests of reaction time (left and right hand reaction time), speed (30m sprint: 10m acceleration, flying 20 m sprint and 30m maximum speed) and agility (20m zigzag agility test), respectively. Body mass index was calculated by dividing the weight (kg) by the height squared (m2). The mean (±SD), minimum and maximum values of performance tests were determined. The relationships between the performances on the agility and 10 m acceleration, flying 20 m sprint, 30 m maximum speed and left hand and right hand reaction time tests were determined by Pearson correlations. The relationship between agility and flying 20 m sprint and between agility and 30 m sprint were significantly positive ($p<0.05$). In the other hand relationship between agility and BMI was negative ($p<0.05$). No significant relationship were determined between agility and 10 m sprint, Left Reaction Time and Right Reaction Time ($p>0.05$). As a result, new tests of agility that include specific exercises of taekwondo are encouraged in further researches. Moreover agility test should be included cognitive properties such as anticipation and pattern recognition.

Theodoros et al. (2016) performed the correlational study on "Age- and sex-related differences in the anthropometry and neuromuscular fitness of competitive taekwondo athletes". t. The aim of the study was to examine the anthropometry and neuromuscular fitness of TKD athletes by sex and age. A total of 393 athletes (7–48 years old), separated into six age groups (7–9, 10–11, 12–13, 14–17, 18–32, and 33+), were examined for anthropometry and performed a series of neuromuscular fitness tests (flexibility, agility, muscle power, and isometric strength). The statistical software IBM Statistical Package for the Social Sciences (SPSS) v.23.0 (SPSS, Chicago, IL, USA) performed all statistical analyses. Mean values and standard deviations were calculated for all variables. A two-way analysis of variance examined the main effects of sex and age and the sex × age group interaction on these anthropometric and physiological characteristics. Quintiles were

calculated for all variables using the 20th, 40th, 60th, and 80th percentile. Significance level was set at a=0.05. Mean values and standard deviations were calculated for all variables by sex and age group (Table 1). A main effect of age on body mass ($p<0.001$, $\eta2=0.585$), body height ($p<0.001$,$\eta2=0.698$), BMI ($p<0.001$, $\eta2=0.298$), and BF ($p=0.009$,$\eta2=0.039$) was observed, where the older age groups were heavier and taller (but no difference among 14–17, 18–32, and 33+ groups) than their younger counterparts (Figure 1,Table 2). A main effect of sex on body mass (48.2±13.5 vs52.1±16.5 kg, in females and males, respectively; $p<0.001$,$\eta2=0.046$), body height (154.2±12.7 vs. 159.4±16.5 cm; $p<0.001$, $\eta2=0.050$), and BF (20.4%±5.0% vs. 14.8%±4.7%; $p<0.001$, $\eta2=0.169$), but not on BMI (19.9±3.3 vs19.9±3.2 kg/m2 ; $p=0.130$, $\eta2=0.006$), was shown. An age × sex interaction on body mass ($p<0.001$, $\eta2 =0.057$), body height ($p<0.001$, $\eta2=0.115$), and BF ($p=0.003$, $\eta2=0.045$), but not on BMI ($p=0.172$, $\eta2=0.020$), was observed, too; that is, a larger difference in body mass and body height between 12–13 and 14–17 groups was observed in males than in females; the sex difference in BF was greater in the 14–17 than in the 12–13 age group. Although both females and males differed in body dimensions in the 12–13 and 14–17 age groups, a greater difference between these two age groups in body mass and body height was observed in males than in females. There was no sex difference in BMI, which was in agreement with the previous studies on TKD.9,22 This lack of difference should be attributed to the relatively low BMI of males rather than to the increased BMI of females and reflected a likely advantage of the athletes with relatively low BMI, that is the athletes who were relatively tall (and consequently with long limbs) and competed in relatively “light” weight categories.

Kankanala et al. (2010) conducted his study on “Anthropometric characteristics of selected combat athletic groups”. Physical performance efficiency and effectiveness in different sports depends to a large on the size, weight and proportion of the physique of the athlete. Several kinanthropometric studies have shown significant associations between anthropometric characteristics of judo, karate and taekwondo combat athletic groups. To achieve the purpose of the study anthropometric characteristics of 80 judo (45 males and 35 females), 90 karate (40 males and 50 females) and 60 taekwondo (35 males and 25 females) who have been training for atleast 3 years have been measured. The anthropometric measures include body mass, standing height, abdominal circumference, waist circumference and hip circumference. These measurements were made by following the standards of anthropometric protocols of the international working group of

kinanthropometrics. Differences between the male and female subjects of each group were determined. The results revealed greater waist circumference (92.80 0.75 cm), waist hip ratio (0.70 0.01 cm) and conicity index (174.93 1.27) of male judo groups compared to those of male karate and taekwondo groups. However male karate groups have higher mean value for triceps (7.29 0.22 mm), biceps (7.73 0.21 mm) compared with those of judo and taekwondo groups, whereas male taekwondo groups have significantly higher mean value for height (172.91 1.12 cm) and hip circumference (136.40 1.21 cm) compared to male judo and karate groups. Among the female combat athlete groups, karate groups have significantly higher value for triceps (15.10 0.29 mm) and biceps (13.30 0.36 mm) compared to the female judo and taekwondo groups. However female taekwondo group was heavier (66.08 1.30 kg) and have higher conicity index (159.69 2.01) than the female judo and karate groups. The difference between the selected female combat athletic groups in height, body mass index, abdominal circumference, waist circumference, hip circumference and waist hip ratio were insignificant.

Noorul et al. (2008) conducted the research on Physical Fitness of Recreational Adolescent Taekwondo Athletes. The purpose of this study was to describe the physical fitness of adolescent recreational taekwondo athletes. Subjects were members of the Kelantan State taekwondo team from Malaysia (8 males, 18.63 ± 1.92 years, 168.65 ± 7.36 cm, 68.29 ± 20.69 kg, and 9 females, 18.10 ± 1.37 years, 158.22 ± 4.11 cm, 59.72 ± 10.03 kg). Flexibility, explosive leg power, muscular strength and endurance, aerobic fitness and maximum exercise heart rate (HRex) were assessed. In absolute terms, the boys (52.07 ± 11.07cm) jumped higher than the girls (34.04 ± 5.21 cm, p = 0.001, eta2 = 0.476). The difference became smaller when jump height was scaled to height (m2) (17.39 ± 3.07 cm/m2 and 14.25 ± 1.66 cm/m2 for the boys and girls, respectively, p = 0.020, eta2 = 0.331). There was no difference between boys (25.00 ± IR15) and girls (31.50 ± IR 17) in push-ups, although the females recorded a higher median score (p = 0.335, ES = 0.406). There also was no difference between gender (39.00 ± IR7 vs. 39.50 ± IR11) in sit-ups (p > 0.05, ES = 0.054). The boys had greater aerobic endurance but the effect was small (42.18 ± 7.86 ml.kg-1.min-1 vs. 30.71 ±5.46 ml.kg-1.min-1, p = 0.003, eta2 = 0.453). The difference persisted when height was used as a co-variate (43.32 ± 8.44 ml.kg-1.min-1 for the boys and 29.70 ± 8.283 ml.kg-1.min-1 for the girls, p = 0.012, eta2 = 0.375). In conclusion, sexual dimorphism in physical fitness was found in recreationally active adolescent athletes.

Sevinc et al. (2015) performed the comparative study on "A study on some motoric and anthropometric attributes of competitive and non-competitive taekwondo athletes between the age group 9-12 years". The aim of this study is to examine some motoric and anthropometric attributes of competitive and non-competitive taekwondo athletes within the age group 9-12 years and to determine the difference between those two groups. 31 competitive and 29 non-competitive licensed taekwondo athletes voluntarily participated in the study. The average ages, heights and weight of competitive and non-competitive athletes were 11,16±,93 year, 150,58±17,14 cm and 43,80± 13,97 kg, 9,62±,82 year, 137,31±8,80 cm and 35,24±8,28 kg respectively. Both groups have been practising regularly taekwondo for 2,5 years, 2 days a week and two hours a day. Flamingo balance test, test of disk touching, sit and reach flexibility test, long jump while standing still, 30 sec sit-up test, bent arm pull-up test and 10x5m push up run, right and left hand grip strength test and 20 m shuttle run of the Eurofit test battery were used. Body fat percent, body fat mass, fat free mass, body mass index values were measured. Such anthropometric attributes as hand length, calf and femur circumference, arm length, biceps circumference in flexion, arm span length were measured. Results of statistical analyses showed a significant difference between two groups in terms of motoric scores ($p<0,01$, $p<0,001$), anthropometric characteristics ($p<0,01$, $p<0,001$), and fat free mass ($p<0,001$) in favour of the competitive group. Compared with the non-competitive group, significant differences in competitive group can be explained by their active participation in competitions.

PROCEDURE AND METHODOLOGY

In this chapter, the procedure adopted for conducting the research study, selection of subjects, selection of independent and dependent variables, criterion measures, procedure for collection of data and statistical techniques has been described.

Selection of subjects

For the purpose of the study, 30 male subjects from fin weight category will be selected from senior national taekwondo championship. The sampling technique for the selection of subjects used will be purposive sampling method.

Selection of variables

Based on literally evidence, correspondence with the expert and scholar's own understanding and keeping feasibility criterion in mind, the selected variables are as follows:

Anthropometric Variables-:

1. Standing Height
2. Sitting Height
3. Iliac height
4. Iliac to knee length
5. Knee Height
6. Weight
7. Biepicondylar Width of the Femur
8. Bi-iliocristal Width
9. Calf girth
10. Thigh girth
11. Body Mass Index
12. Skin Fold Thickness(3 site)

Dependent Variables:-

Performance of players in senior national championships in last 3 years will be taken as an dependent variable.

Administration of the test and collection of the data

Standing Height:-

Aim:- To measure the standing height of the subjects.

Equipment:- stadiometer, pen, paper.

Procedure:- Standing height is the measurement of maximum distance from the floor to the highest point of the head, when the subject is facing parallel and directly straight ahead. Shoes should be off, feet together, and arms by the side of the body. Heels, buttocks and upper back should also be in contact with the wall when the measurement is made.

Scoring:- The height will be recorded to the nearest 0.1 centimeter.

Sitting Height:-

Aim:- To measure the sitting height of the subjects.

Equipment:- stadiometer or ruler placed against a wall, box or chair.

Procedure:- The subject sits with both feet on the floor, the lower back and shoulders against the wall, looking straight ahead. Distance can be measured from the floor, and the height of the box measured and subtracted from the total distance.

Scoring:- The sitting height will be recorded to the nearest 0.1 centimeter.

Iliac Height:-

Aim:- To measure iliac height of the subjects.

Equipment:- Large sliding caliper or stadiometer, pen and paper.

Procedure:- The subject will stand erect face parallel arms by the side of the body with normally distributed weight on both the legs equally. The height is then measured from the widest edge of the iliac to the floor.

Scoring:- The iliac height will be recorded to the nearest of 0.1 centimeter.

Iliac to Knee Length:-

Aim:-To measure the iliac to knee length of the subjects.

Equipment:- large sliding caliper, pen and paper.

Procedure:- The subjects will stand erect. Then the length is measured from the widest edge of iliac to the lateral condylar part of the knee.

Scoring:- The length will be recorded to the nearest of 0.1 centimeter.

Knee height:-

Aim:- To measure the knee height of the subjects.

Equipment:- large sliding caliper, chair or box, pen and paper

Procedure:- The subject will sit on the chair or the box in erect position with placing both feet flat on the floor and making 90 degree angle at the knee joint. Sliding caliper's rigid end is placed under the heel just below the malleolus bone and the moving end of caliper is placed right above the patella and pressed to remove muscle fat.

Scoring:- The knee height will be recorded to the nearest 0.1 centimeter.

Weight:-

Aim:- To measure the body weight of the subjects.

Equipment:- weighing machine, pen and paper

Procedure:- Weighing machine is used to measure the body weight. The subject is asked by the researcher to stand on the weighing machine and subject will be instructed that he should be barefooted and wearing minimum possible clothes during the assessment.

Scoring:- Body weight will be recorded to the nearest 0.1kg.

Biepicondylar width of the Femur:-

Aim:- To measure biepicondylar width of the femur of subjects.

Equipment:- small sliding caliper, pen and paper.

Procedure:- Biepicondylar width of femur is measured by placing the small sliding caliper at the widest distance between medial and lateral condyles of the femur.

Scoring:- The biepicondylar width of femur will be recorded to the nearest of 0.1 centimeter.

Bi-iliocristal Width:-

Aim:- To measure the bi-iliocristal width of the subjects.

Equipment:- Sliding caliper, pen and paper.

Procedure:- Bi-iliocristal width is measured by placing the sliding caliper at the widest edges of the iliac bone on the sides.

Scoring:- The bi-iliocristal width will be recorded at the nearest of 0.1 centimeter.

Calf Girth:-

Aim:- To measure the circumference of calf of the subjects.

Equipment:- flexible measuring metal tape, pen and paper.

Procedure:- The subject will stand erect with normally distributed weight on both the legs. Girths are always measured on the right side of the body. The girth of calf is then measured at the largest circumference of the calf by using flexible measuring metal tape.

Scoring:- The calf girth will be recorded at the nearest of 0.1 centimeter.

Mid Thigh Girth:-

Aim:- To measure the circumference of mid thigh of the subjects.

Equipment:- Flexible measuring metal tape, pen and paper.

Procedure:- The subject will stand erect with normally distributed weight on both the legs. The mid-point is then marked between the trochanterion and tibiale laterale. The girth is then measured at that marked point by using flexible measuring metal tape.

Scoring:- The thigh girth will be recorded at the nearest of 0.1 centimeter.

Body Mass Index:-

Aim:- To calculate the body mass index of the athletes.

Equipment:- Stadiometer, weighing machine, calculator, pen and paper.

Procedure:- The values of height and weight are used to calculate the body mass index of the subjects. The formula is **BMI = weight kg/height m^2** where person's weight is in kilograms (kg) and height is in metres squared (m^2).

Scoring:- The BMI will be recorded to the nearest of 0.1 kg/m^2.

Body Fat Percentage (Skin fold thickness):-

Aim:- To measure the body fat percentage of the subjects.

Equipment:- Skin fold caliper, pen and paper.

Procedure:- Body Fat Testing will be measured by three Sites for Men:-

- Chest: The "midaxillary line" Halfway between nipple and the crease of the armpit is the point.
- Abdominal-Make a vertical fold one inch to the right of the navel.

- Thigh: The midpoint between the hip and the knee and use a vertical fold. Grasp a vertical fold of skin for the measurement.

  All the measurements will be taken at the right side of the body.

  Scoring:- The values recorded will then be used in Siri's formula to calculate the body fat percentage.

STATISTICAL TECHNIQUE

In order to test the hypothesis of the study, descriptive statistics such as (mean, standard deviation, minimum value, maximum value, range) and Pearson coefficient of correlation technique will be employed to analyze the taekwondo performance in relation to selected anthropometric measurements and level of significance will be set at 0.05.