Chapter II

REVIEW OF RELATED LITERATURE
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In this chapter a brief review of literature has been presented. Attempts were made to locate literature related in several angles with the present study. These reviews were useful to make available explanation for verification in the concerned areas and to expand the sphere of knowledge. Reviews were also helpful to avoid the risk of duplication. All the literatures were available in the form of books, journal, reviews, internal and other documents. All the review of related literature categorize into three heads:

1. Studies related to anthropometry and ethnic group.
2. Studies related to weight training and physical fitness variables.

Studies related to anthropometry and ethnic group

The origin of anthropometry is very ancient. Serious thought has been given to expand the field. Anthropometric measures are related to body segments and it also deals with body type. Both the factors are responsible for better physical performance as well as various components of physical fitness. The anthropometric characteristics of Rajbangsi community is quite different from that of general group as mentioned in the introductory chapter. Here a few research report are stated below:

Pakrasi et.al (1988) conducted a cross sectional study on 815 healthy Bengali boys aged 7-16 years. Mean values of height or weight of the boys not representative for all school going boys of Calcutta are distinctly above the national standards given by the Indian Council of Medical Research. They are shorter and lighter than the well-off boys of India but have a similar magnitude of subcutaneous fat on arm. Peak annual incremental growth in height and weight occurs in Bengali boys at 12-13 years and 14-15 years respectively. This is about one year earlier than in the well-off Indian, British or American boys.

Reddy et.al (2000) conducted a cross sectional study on 1565 Sugali Children (854 boys and 711 girls) aged 1-20 years. All anthropometric measurements (height, weight, upper arm circumference, biacromial diameter, billicristal diameter, chest circumference, head circumference) except skinfold measurements (triceps, subscapular, suprailliac and medical calf) exhibit uniform increase with age in both the
sexes. A gradual increase in four skinfold measurements is observed with age in the case of girls, whereas slight decrease is observed in the case of boys. The Sugali boys and girls are shorter and lighter than well-to-do Indian standards. The median heights and weights of Sugali boys and girls fall below the 5th percentile of NCHS standard.

Mitra et al. (2002) conducted a cross sectional study on 655 Kamar Children (341 boys and 314 girls) aged 5-18 years. All anthropometric measurements (height, weight, sitting height, biacromial diameter, biiliocystal diameter, upper arm circumference, calf circumference) except skinfold thickness (triceps and subscapular) exhibit uniform increase with age in both sexes. However, when height and weight of the Kamar boys and girls were compared with the data for other tribes and for all India, the Kamar children (both boys and girls) indicated lower weight and height and the difference showed to be significant, for almost all ages. Kamar boys showed higher anthropometric values than girls in almost all measurements except in biiliocystal diameter and in measured skinfolds. Poor socio-economic status of this primitive tribe may be one of the reasons for this poor growth pattern.

Tiwari et al. (2007) conducted a cross sectional study on 551 children (283 boys and 268 girls) aged 4 to 18 years. All anthropometric measurements (body weight, height, sitting height, head circumference, upper arm circumference, chest circumference) excepts skin fold measurement (biceps, triceps, sub-scapular, calf) exhibit uniform increase with age in both the sexes. Age-specific BMI indicated substantial changes and falls during pre-school age and rise in adolescence. The BMI according to the Indian standard was normal, but when the data was compared with International standard malnutrition in both sexes was noticed in children. Boys remained undernourished after adolescence, while girls reached the normal growth pattern.

Mohamed et al. (2009) examined the basic morphological and fitness measures under – 14 and under – 16 male youth handball players differ from reference samples of the same age. The result showed that under – 16 handball players were significant in height and physical fitness than the reference group. Under-16 elite players were hearing and had greater muscle circumference than their non-elite peers. Elite players significantly better on strength, speed and agility and cardio respiratory endurance. Maturation was a significant covariate in anthropometric measures but not in physical performance. Specific anthropometric measures, in addition to some performance measure (running speed, agility), are useful for talent identification in youth handball.
Mark (2011) investigated the anthropometric and performance characteristics of 43 soccer players (ages 15 ± 2 year, height 1.71 ± 0.08 m., mass: 63.9 ± 9.4 kg) who represented a UK-based Championship Club in terms classified according to chronological age (i.e. under 14, under 16 or under 18 years of age). The under 18s age group were taller, heavier, jumped higher, sprinted faster and possessed a greater maximal aerobic capacity than the under 14s players. However, players from the two youngest age groups were similar in all measurements. Additionally, high or low CMJ performances were able to differentiate between sprint times over 15m and 30m. These results characterize the anthropometry and performance of UK-based soccer players of varying ages while highlighting the discriminative ability of certain tests to differentiate between sprint performance.

Qamra et.al (2012) carried out a study on 795 Baiga children (453 males and 342 females) aged 1-18 years. All body measurements (weight, height, sitting height, lengths, breadths, circumference) except for skinfolds increased progressively in each age group showing insignificant difference between boys and girls in most of age groups with no evident peak velocity during pubertal age in both sexes. The present children were slightly heavier and taller than tribal children of other areas but lighter and shorter than Bharia Children. However, these children were comparable with all India rural children but found below 10th percentile when compared with NCHS standards. The absence of peak velocity and poor growth in studied children may be due to low intensity of growth rate. Proportionate changes observed in the present study were similar to Indian Punjabi Girls.

Sil (2012) conducted a study on somatotype physical growth status and motor fitness profile of 10 to 14 years boys of Rajbansi community of Coochbehar. According to his study the mean and S.D. value of height and weight of 12-14 years boys were 140.22 ± 8.02 cm & 30.84 ± 6.69kg, 145.63 ± 8.18cm & 34.72 ± 7.44kg and 151.18 ± 10.34 cm & 38.93 ± 9.97kg respectively. The mean & SD value of sit-up of 12-14 years boys 19.38 ± 7.33, 21.38 ± 7.13 and 21.67 ± 5.78 respectively and speed of 12-14 years boys were 8.07 ± 0.60 sec, 7.84 ± 0.79 sec. and 7.80 ± 0.75 sec. respectively.

Torres-Unda et.al (2013) investigated the anthropometric, physiological and maturation characteristics of young players (13-14 years old) associated with being successful in basketball. Body parameters were measured (stature, total body mass, skinfold and length) and physiological capacities were assessed by endurance, sprint
(20m), jump and dribbling tests. Anthropometric analysis indicated that elite players were taller, heavier and had a higher percentage of muscle and physiological testing showed that these elite players perform better in jump, endurance, speed and agility tests. Those who are more mature have advantages in anthropometric characteristics and physiological test results. Around puberty, physical and physiological parameters associated with maturity and chronological age are important in determining the success of basketball players.

**Studies related to weight training and physical fitness variables**

A landmark study by Vrijens (1978), reported the results of an 8 week resistance training programme done three times per week by boy. The pre adolescents were incapable of increasing strength or the muscle cross-sectional area of the extremities; However, the adolescents increased strength in all muscle groups tested.

Hakkinin and Kami (1983) reported that the initial increase in strength in adult subjects were attributed to neural factors rather than muscle hypertrophy resulting from strength training.

McGovern (1984) conducted a study on the effect of circuit weight training on the physical fitness of prepubescent children on 42 girls and boys of 4-6 grades. Subjects were involved in circuit weight training for 12 weeks. They concluded that these subjects showed significant strength gains, when compared with the control group.

Weltman et.al. (1986) concluded that strength gains seen in strength trained children are due to various neural adaptations, actual muscle size is not increased in the prepubescent children.

Rians and associates (1987) found significant strength gains in a group of prepubescent boys who used circuit weight training over or 12 week period.

Belmkie (1989) opined that strength increases tremendously from childhood to adulthood with the greatest during the adolescent years. Prior to adolescence, strength increases linearly and this is the same for both boys and girls. At the age of 3 boys show a small strength advantage than girls and these differences remains constant throughout preadolescence. As puberty approaches from males, around the age of 13 or 14, strength increases at a great rate due to hormonal factors. At the age of 7 female
have approximately 92% of the absolute strength of male, whereas by the age of 18
they have less than 60% of the absolute strength of males.

Maffulli et.al. (1994) found that athletics boys until the age of 15 years had
similar isometric quadriceps strength as did non-athletic boys and after this age the
strength of the athletic group was significantly higher compared with non-athletic
boys.

Dowling et.al. (1994) reported that humans are unable to fully activate their
muscle voluntarily; however, strength training can improve this activation.

Clapp et.al (1995) studied on the effect of six weeks of resistance training on
isometric and isotonic strength in adolescents. Subjects (age 14-18 years) were
measured for isotonic (bench press, squat press) strength and isometric (sum of grip,
arm curl and back lift) strength prior to a six-week isotonic resistance training
programme. Subjects were retested at the end of this period. The result of this
suggests that a six-week isotonic training programme was equally increased strength
in adolescent boys and girls. For boys there was a strong linear relationship between
isometric and isotonic strength measures, but for girls there was no relationship
between these variables.

Kramer et.al (1997) examined the effects of a single set of weight training
eexercise to failure and 2 multiple-set protocols (not to failure) on the IRM parallax
squat. Body mass, body composition and the IRM parallel squat were assessed at
baseline and at weeks 5 and 14. Results showed no significant changes in body mass
or body composition. The IRM squat increased significantly. Differences in IRM
between groups indicated that MS (Multiple set) and MSV increased approximately
50% than SS (Single Set) over the 14 weeks. Results suggest that multiple sets not
performed of failure produce superior gains in the I-RM.

Payne, Morrow Jr., Johnson and Dolton (1997) observed that resistance
training appears to enhance muscular endurance and strength in children and youth.
The magnitude of the effect appears to be a function of gender training method and
experimental design.

Guy et.al (2001) studied that strength or resistance training for young athletes
has become one of the most popular and rapidly evolving modes of enhancing athletic
performance. Early studies questioned both the safety and the effectiveness of
strength training for young athletics, but current evidence indicates that both children
and adolescents can increase muscular strength as a consequence of strength training. This increase in strength is largely related to the intensity and volume of loading and appears to be the result of increased neuromuscular activation and coordination, rather than muscle hypertrophy. Training induced strength gains are largely reversible when the training is discontinued. Given proper supervision and appropriate programme design, young athletes participating in resistance training can increase muscular strength.

Faigenbaum (2001) observed that children should not attempt a maximum lift (IRM). Proper form and execution of all exercises is for more important than the amount of weight lifted. It is recommended that during the initial stage of learning, children should perform the exercises with no resistance.

2-3 days of training will provide benefits. Each session should begin with a warm up, preferably cardiovascular. Next the child perform one exercise for each main muscle group using 12-15 rep range. The weight session should be followed by a cool-down and stretching.

Guy, J.A. and Micheli, L.J (2001) indicates that both children and adolescents can increase muscular strength as a consequence of strength training. This increase in strength is largely related to the intensity and volume of loading and appears to be the results of increased neuromuscular activation and coordination, rather than muscle hypertrophy and also proper supervision and appropriate programme design.

Neu el.al (2002) and Veldhuis et.al (2005) in their study found that muscle cross sectional area (CSA) was influenced by hormonal change. They also found that the increase in grip strength per muscle CSA was similar in both male and females, thus it appears to be independent of hormones.

Folk and Fliakim (2003) stated that resistance training in youth and its effectiveness, possible effect on growth and safety considerations, has received considerable public and scientific attention in recent years.

Malina (2006) concluded that experimental training protocols with weight and resistance machines and supervision and low instructor / participant ratios are relatively safe and do not negatively impact growth and maturation of pre and early pubertal youth.

Gabriel at al (2006) suggested that the strength increase is often attributed to neuromuscular adaptation.
Christou et al (2006) showed that soccer training alone improves more than normal growth maximum strength of the lower limbs and agility. The addition of resistance training, however, improves more maximal strength of the upper and lower body, vertical jump height and 30m speed. Thus, the combination of soccer and resistance training could be used for all an overall development of the physical capacities yound boys.

Yespelkis, Ben B (2006) showed that resistance training can improve glucose transport in both normal and insulin-resistant skeletal muscle by enhancing the activation of the insulin signaling cascade and increasing GLUT – 4 protein concentration. These training induced alteration improve the quality of the skeletal muscle and can occur independent of significant increase in skeletal muscle mass.

Santos and Janeria (2008) reported the result support the use of complex, training to improve the upper and lower body explosively level in young basket ball players. This study also should that more strength conditioning is needed during the sport practice session. Furthefmore, complex training is useful working tool for coaches, innovative in this strength training domain, equally contributing to better time efficient training.

Chanaell and Barfield (2008) reported that compare the effects of a ballistic resistance training programme of Olympic lifts with those of a traditional resistance programme of power lifts on vertical improvement in male high school athletes. Finding from the current study indicate that Olympic lifts as well as power lifts provide improvement in vertical jump performance and Olympic lifts may provide a modest advantage over power vertical jump improvement in high school athletes.

Anderson et.al (2008) indicated that training with CR (combined elastic and free weight resistance) may be better than FWR (Free weight resistance) alone for developing lower and upper body strength and lower body power in resistance trained individuals. Long term effects are unclear but CR training makes a meaningful contribution in the short term to performance adaptations of experienced athletes.

Faigenbaum, Kraemer et.al. (2009) reported that the current position of National Strength and Conditioning Association (NSCA) are:

A properly designed and supervised resistance training programme-

i. Is relatively safe for youth.
ii. Can enhance the muscular strength and power of youth.

iii. Can improve the cardiovascular risk profile of youth.

iv. Can improve motor skill performance and may contribute to enhanced sports performance of youth.

v. Can increase a young athletes resistance to sport related injuries.

vi. Can help to improve the psychological well being of youth.

vii. Can help to promote and develop exercise habits during childhood and adolescence.

Dorgo, King et al (2009) reported that at baseline there were no significant differences among the three groups for most measures. Compared with baseline the experimental groups improved significantly in all 6 fitness measure and showed more improvements that the control group in most fitness measures both at 9 and 18 weeks. Hone of the groups showed significant improvement in body composition. The result documented that an MRT (Manual Resistance Training) complement PE (Physical Education) programme was effective in improving adolescents muscular fitness. An 18 week combined MRI and cardiovascular endurance training programme effectively improved cardiovascular and muscular fitness but was ineffective in improving adolescent body composition. An MRT-based exercise session requires minimal equipment and set-up and can be performed in a short period of time and therefore it is suitable for application in regular PE setting.

Dahab and Mc Cambridge (2009) studied to clarify some common myths associated with strength training in children. Children can improve strength by 30% to 50% after just 8 to 12 weeks of a well designed strength training programme. Youth need to continue to train at least 2 times per week to maintain strength. The case reports of injuries related to strength training, including epiphyseal plate fractures and lower back injuries are primarily attributed to the misuse of equipment, inappropriate weight, improper technique or lack of qualified adult supervision. Youth athletes and non athletes can successfully and safety improve their strength and overall health by participating in a well-supervised programme.

According to American College of Sports Medicine (2009) recommended that strength programme sequence exercises to optimize the preservation of exercise intensity (large before small muscle group exercise, multi joint exercises before single
joint exercises and higher-intensity before lower-intensity exercise). For novice it is recommended that loads correspond to a repetition range of an 8-12 RM. When training at a specific RM load, it is recommended that 2-10% increase in load be applied when the individual can perform the current workload for one or two repetitions over the desired number. The recommendation for training frequency is 2-3 days / week for novice training, 3-4 days / week for intermediate training and 4-5 days / week for advanced training. For local muscular endurance training, it is recommended that light to moderate loads (40-60% of IRM) be performed for high repetitions (>15) using short rest period (<90 Sec).

Faigenbaum, A.D. and Myer, G.D. (2010) reported that regular participation in a multifaceted resistance training programme that begins during the preseason and includes instruction on movement biomechanics reduce the risk of sports related injuries in young athletes.

Mayhaw et.al (2010) reported that strength changes were not significantly correlated with RTE (repetition to fatigue) change in BP (Bench press) or S.Q (Squat). Adolescents men and women make comparative increases in BP after resistance training, but women may have a great capacity for increasing SQ. Relative muscular endurance is not altered by short term increases in muscle strength for upper or lower body exercises. Given the same training programme adolescent women show comparative percent increases in upper body strength but greater gains in lower body strength than adolescent men.

Faigenbaum and Myer (2010) indicated that resistance training can be a safe, effective and worthwhile activity for children and adolescents provided that qualified professionals supervise all training sessions and provide age – appropriate instruction on proper lifting procedure and safe training guidelines. Regular participation in a multifaceted resistance training programme that begins during the preseason and includes instruction on movements biomechanics may reduce the risk sports related injuries in young athletes.

Miller et.al (2010) studied that the benefit and possible detriment of resistance training. When developing a resistance training programme for adolescents, be cognizant of any pre-existing health conditions and experience level of the adolescents. For strength training, the adolescents should begin with exercises that involve all major muscle groups with relatively light weight, 1-3 sets of 6 to 15
repetitions, 2-3 non-consecutive days per week. As the adolescence becomes more experienced, gradually increase loads and add multi joint exercises. Each session should be properly supervised for safety and to provide feedback on technique and form, regardless of the resistance training experience of the adolescent.

Behringer et.al (2010) studied to assess the effects of resistance training in different age groups and maturity. Two independent reviewers evaluated the effects of resistance training on muscle strength for prepubertal and post pubertal healthy, children and adolescents (Younger than 18 years) by using the results of randomized and nonrandomized controlled trails. The results of the analysis indicated that the ability to gain muscular strength seemed to increase with age and maturational status but there was no noticeable boost during puberty. Furthermore, study duration and the number of performed set were found to have a positive impact on the outcome.

Granacher et.al. (2011) reported that the impact of a short term ballistic strength training (BST) following by detraining on measures of strength and postural control in adolescents. The high school students (Age-16.7± 0.6 years) were participated in a short term (8 week) lower extremity BST programme 2 times a week integrated in their regular physical education lessons. Ballistic strength training resulted in statistically significant improvement in maximal isometric force (MIF) and counter movement jump (CMJ). These results have an impact on improving the performance level in various motor fitness skills and sports activities in physical education.

Gramacher et.al (2011) reported that in adolescents, lower extremity BST (Ballistic strength training) is a suitable training modality for the application in a school setting (Particularly during physical education lessons) that produced transient improvements in strength variables. These results could have an impact on improving the performance level in various motor fitness skills and sports activities in physical education.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Evidence – Based Recommendation</th>
</tr>
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<tbody>
<tr>
<td>Frequency</td>
<td>Major muscle groups should be trained 2-3 days \ week with a 48 – hour rest between sessions for muscle groups.</td>
</tr>
<tr>
<td>Intensity (Strength)</td>
<td>40-50% of IRM or very light to light load for beginning older personal and for beginning sedentary persons.</td>
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<td></td>
<td>60-70% of IRM or moderate to hard for novice to intermediate adult exercisers.</td>
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<td></td>
<td>≥ 80% of IRM or hard to very hard load for experienced weight lifters.</td>
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<tr>
<td>Intensity (Endurance)</td>
<td>&lt; 50% of IRM or light to moderate load</td>
</tr>
<tr>
<td>Intensity (Power)</td>
<td>20-50% of IRM or very (very) light to light load in older adults.</td>
</tr>
<tr>
<td>Repetitions</td>
<td>10-15 repetitions to improve strength in beginning, middle aged and older persons 8-12 repetitions to improve strength and power in most adults.</td>
</tr>
<tr>
<td></td>
<td>15-20 repetitions to improve muscular endurance in most adults.</td>
</tr>
<tr>
<td>Sets</td>
<td>Single set training for novice and older adults 2-4 sets are recommended for strength and power of most adults.</td>
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<tr>
<td></td>
<td>≤ 2 sets for muscular endurance.</td>
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<tr>
<td>Rest</td>
<td>2-3 minutes of rest between multiple set training.</td>
</tr>
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</table>

Santos, Marinho et.al (2012) showed that significant training induced differences were observed in 1 and 3 kg medicine ball throw gains (GR: + 10.3 and + 9.8% respectively; GCOM : 14.4 and + 7% respectively) whereas no significant changes were observed after a DT period in both the experimental group. Significant training induced gains in the height and length of the counter movement jumps were observed in both the experimental group. No difference were perceived after a DT period in lower limb power. Time at 20m decreased significantly for both intervention programmes but either GR or GCOM groups kept the running speed after a DT period.
of 12 weeks. After training, the VO\textsubscript{2} max increased only significantly for GCOM. A significant loss was observed after a DT period in GR but not in GCOM. Performing resistance and endurance training in the same workout does not impair strength development in young school boys. As expected, strength training by itself does not improve aerobic capacity. Our results also suggest that training programmes effects even persist at the end of the DT period. [GR=Resistance group alone; DT = Detraining; GCOM = Combined resistance and endurance training]

Santos and Jauera (2012) reported the results of the effects of a lower and upper body 10-week in season resistance training programme on explosive strength development in basket ball players. The results of this study show that a 10 week in season resistance training programme with moderate volume and intensity loads increased vertical jump and Medicine Ball Throw (MBT) performances in adolescent male basketball players. Coach should know that such a short resistance training program specifically designed for young basketball players induce increased explosively levels, which are essential to a better basketball performance, with no extra overload on adolescents skeletal muscle development.

Klusemaua e.l.al. (2012) reported that video based resistance training appears to be a viable option to improve physical performance and strength in junior basketball athletes.

Tibania e.t.al. (2012) showed the results of this study that adolescents present and higher recovery capacity between sets in a resistance training session than adults and a lower rest interval results in a higher number of repetition completed total training volume and resistance to fatigue.

Ratamese e.t.al. (2012) showed that significant negative correlations were observed between IRM bench press and total number of repetitions completed for 1 minute and 2 minute rest intervals (RIs) (r=–0.558 and – 0.490 respectively). These data indicate that strength plays a role in bench press performance with varying RIs and suggest that shorter RIs may suffice in women to attain a specific volume.

Rockie e.t.al (2012) reported the effects of different speed training protocols on sprint acceleration kinepoatics and muscle strength and power in field sport athletes. This study showed that the weight training (WT) and plyometric training (PT) groups increased the 5 to 10m velocity by approximately 10%. All the groups increased step
length for all distance intervals. The WT group increased absolute and relative strength measured by a 3 repetition maximum squat by approximately 15%. Step length was the major limiting sprint performance factor for the athletes in this study. Correctly administered, each training protocol can be effective in improving acceleration. To increase step length and improve acceleration, field sport athletes should develop specific horizontal and reactive power.

Kristensen and Franklyn Miller (2012) reported that RT (Resistance training) can increase muscle strength, reduce pain and improvement functional ability in patients suffering from CLBR (Cronic low back pain), knee osteoarthritis and chronic tendinopathy and those under recovery after hip replacement cement surgery.

Marjan (2012) evaluated the difference in bench press and squat. Maximal strength indicates by are one-repetition maximum (IRM) test after 8 weeks instability resistance training. Fifty physically active but inexperienced resistance trained versatility aged sport science students were trained twice per week for 8 weeks. Both exercises (bench press and squat) were performed with a previously established 50% of IRM. Although 80% of IRM is usually required to improve muscle strength, this study has demonstrated that resistance training with a previously established 50% of IRM may be considered effective for previously inexperienced young individuals. Resistance exercises performed under unstable conditions are more efficacious for improving maximal muscle strength than traditional stable exercises in inexperienced resistance trained subjects.

Hopper et.al. (2013) reported the effects of resistance training fatigue on joint biomechanics. This study demonstrated that there are lasting residual effects on movement capabilities after a high-intensity short rest protocol. Thus, strength and conditioning coaches must be careful to monitor movements and exercise techniques after such work outs to prevent injury and optimize subsequent exercise protocols that might be sequences in order.

Kobayashi, Hirayana et.al (2013) reported that RTD (Rate of torque development) increased after the 6 week explosive type strength training but returned to the pre-training level after the 3 week short term detraining. It is necessary to take into account the time point at which we evaluate the effect of training after explosive type strength training.
Miyachi (2013) showed high intensity resistance training is associated with increased arterial stiffness in young subjects with low baseline levels of arterial stiffness.

Schrang and Tomkonson et. al (2013) reported that significant difference between the intervention and control groups were observed at 3 month and 6 month assessments for exercise self efficacy, resistance training confidence and self esteem. Large increases in strength for the intervention group relative to control were also observed with no substantial changes in body compose shown for either group. Values for all variables returned to baseline following completion of the programme.

A 6 month resistance training intervention can positively affect the self concept and strength of over weight and obese adolescent boys.

Meinhardt et.al (2013) studied on 102 school children (age 10-14 years) in Switzerland and gave a guided strength training programme (twice a week) for 19 weeks. Targeted strength training significantly increases daily spontaneous PA behavior in boys. The less active children showed the greatest increase in spontaneous physical activity energy expenditure (PAEE). Strength training may be a promising strategy in schools to counteract decreasing levels of PA.

Ramos Veliz et.al (2014) examined the effects of 18 weeks of strength and high-intensity training on key sport performance measures of elite male water polo (WP) players. Subjects were participated in training twice per week. The training programme included upper and lower body strength and high intensity exercises such as bench press, full squat, military press, pull ups, countermovement jump (CMJ) and abs. Specific strength and high-intensity training in male WP players for 18 weeks produced a positive effect on performance qualities highly specific to WP.

Ferrete et.al (2014) examined the effects of a 26 week on field combined strength and high-intensity training on the physical performance capacity among prepubertal soccer players who were undertaking a competitive phase of training. After 26 weeks training period significant improvement were found in counter movement jump (CMJ), Yo-Yo intermittent endurance (Yo-YoIE), and flexibility variables for the experimental group. A significant negative correlation was found between 15m sprint time and CMJ and Yo-YoIE in the experimental group. Specific
combined strength and high-intensity training in pre-puberted soccer players for 26 weeks produced a positive effect on performance qualities highly specific to soccer.

Dingley et al. (2015) reported that the resistance training intervention resulted in a very large correlation between dive start velocity and the counter movement jump mean velocity. The 6–week resistance training programme for paralympic swimmers yielded substantial improvements in dryland measures that corresponded with improvements in both timed dive starts and 50m time trial performance, thus highlighting the usefulness of dry-land training for enhancing swimming performance in paralympic swimming.

**Studies related to the relation of thigh girth, calf girth and speed**

Sil (2013) studied the correlation between running speed with selectee anthropometric variables like height, weight, WHR, total leg length, total arm length, thigh girth, calf girth, biceps girth, foot length and chest circumference. From the finding it may be concluded that running speed has strong and significant relationship with chest circumference, thigh girth, calf girth, biceps girth and foot length but not significant relationship with WHR in school going boys. Results also revealed that the height total arm length and total leg length should be considered as the best predictor of running speed than other variables.

Nuhmani and Akhtar (2014) observed the correlation between body composition and functional performance of elite Indian Junior tennis players. The anthropometric data (height, weight, BMI, girth etc.) of each athlete has measured and has been correlated with all the three functional performance tests. The study result showed there was a significant relationship exists between thigh girth, calf girth and 40 yard sprint performance of junior tennis players.

Rathore and Mishra (2016) investigated to find out correlation between independent variables (height, weight, leg length, thigh girth and calf circumference) and dependent variable (speed ability). They were found in their study that significant relationship was found between speed and height, speed and weight, speed and leg length. Significant relationship was also found between speed and thigh girth but not found between speed and calf girth.

Kalayci et al. (2016) observed the relationship between anthropometric parameter and speed performance. From the results of the study, there were significant relationship in between speed values of workgroups and body weight,
shoulder girth, chest girth, trunk girth, waist girth (P<0.05), calf girth (P<0.05). They also concluded that there were significant relationship in between speed values of workgroups and height, forearm length, all arm length, trunk length, leg length (P<0.01), thigh length (P<0.05). Based on these results, it can be stated that when circumference and length measurements increase, speed performance could increase as well.

After critical review of related literature the investigator found that there was dearth of information regarding effect of weight training on selected parameters of Rajbangsi ethnic group. The anthropometric characteristics of Rajbangsi is quite different from that of general group specially in relation to sports performance. The investigator felt that a wide area one anthropometry, sports training and among various ethnic group on Indian subcontinent are untouched. Under this conditions scholar motivated to select the present problem.