Educational Administration: Theory and Practice
2023, 29(3), 431- 445
ISSN: 2148-2403
https://kuey.net/
Research Article

Anthropometric And Nutritional Profile Of Junior Basketball Players: A Correlational Study On Body Mass Index And Trunk Girths

Prajakta J. Nande[1*]

[1*]Department of Home Science, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, Maharashtra-440033, India

Citation: Prajakta J. Nande, (2023), Anthropometric And Nutritional Profile Of Junior Basketball Players: A Correlational Study On Body Mass Index And Trunk Girths, *Educational Administration: Theory and Practice*, *29*(3), 431- 445
Doi: 10.53555/kuey.v29i3.5701

ARTICLE INFO **ABSTRACT**

This research paper presents findings from a correlational study investigating the anthropometric and nutritional profiles of junior basketball players, with a specific focus on the relationship between body mass index (BMI) and neck, chest, waist, and hip girths. The study aimed to provide insights into the physical characteristics and dietary habits of young athletes, informing tailored strategies for performance enhancement and injury prevention. Anthropometric measurements, including BMI and body girths, were collected from a purposively selected sample of female (n=200) and male (n=200) junior basketball players aged between 12 and 15 years. Additionally, dietary intake data were obtained using standardized nutritional assessment tools. Statistical analyses, including z test and correlation coefficients were employed to examine the comparisons and associations between anthropometric parameters and nutritional intake. The results revealed significant correlations between BMI and neck, waist, and hip girths among junior basketball players. Specifically, higher BMI values were positively associated with increased waist and hip girths, indicating a tendency towards greater central adiposity. Furthermore, nutritional analysis indicated variations in energy and macronutrient intake among participants, highlighting the need for personalized dietary interventions. Overall, this study underscores the importance of assessing both anthropometric and nutritional profiles in junior basketball players to optimize their athletic performance and overall health. The findings contribute to the development of evidence-based strategies for training, nutrition, and injury prevention in youth basketball programs.

Keywords: *Anthropometry, Nutrition, Junior Basketball Players, Body Mass Index, Girth Measurements, Correlational Study.*

INTRODUCTION:

Basketball is a sport that demands high levels of physical fitness, skill, and strategic thinking. For junior athletes, the optimization of their physical attributes and nutritional intake is critical to their performance and development. Understanding the anthropometric and nutritional profiles of these athletes can provide valuable insights into their physical conditioning and dietary needs, which are essential for improving performance and minimizing injury risks.

Anthropometric measurements, including Body Mass Index (BMI) and body girths (neck, chest, waist, and hip), are key indicators of body composition and physical health. BMI, calculated from an individual's weight and height, is a widely recognized measure of body fatness and is commonly used in health and sports contexts (World Health Organization, 2020). Neck, chest, waist, and hip girths offer additional information on the distribution of body fat and muscle mass, which can influence athletic performance and health outcomes (Heyward & Wagner, 2004).

Nutritional intake is another critical factor that impacts the growth, development, and performance of young athletes. Adequate consumption of energy and macronutrients—carbohydrates, proteins, and fats—is necessary to meet the high demands of training and competition (Burke et al., 2021). Carbohydrates provide the primary source of energy, proteins are essential for muscle repair and growth, and fats are important for energy storage and metabolic functions (Rodriguez et al., 2009). The interplay between nutritional intake and anthropometric parameters can guide the development of personalized dietary strategies that support optimal performance and health in young basketball players.

Research has shown that tailored nutritional and anthropometric assessments are vital for enhancing athletic performance. For instance, Claudino et al. (2019) demonstrated that individualized nutrition plans significantly improved performance and recovery in young athletes. Similarly, Santos et al. (2014) found specific anthropometric characteristics to be predictive of superior performance outcomes in adolescent basketball players.

This study aims to investigate the relationship between BMI, neck, chest, waist, and hip girths, and nutritional intake among junior basketball players. By examining these variables, the research seeks to provide a comprehensive profile that can inform tailored training and nutritional strategies, thereby supporting the athletic development and performance of young basketball players.

METHODOLOGY:

The present study deals with the assessment of leg measurements, dietary intake with respect to energy, carbohydrates, protein and fat and vertical jump test of girls and boys engaged in regular basketball training.

Sample population and size:

Total 400 regular practicing basketballers (girls and boys) of age group 10 to 15 years were chosen from leading basketball clubs from Nagpur city, Maharashtra, India. 100 girls and 100 boys from each age group of 10 to 12 years and 13 to 15 years) were purposively selected.

Body measurements:

Basketballers were measured for the body measurements like height, weight and body circumferences like neck, chest, waist and hip. Based on body weight & standing height, body mass index (BMI) of basketballers was calculated using the formula [Weight (kg) ÷ Height (m^2)].

Mean values of anthropometric indices of basketball players were compared with the reference standards for age & gender [NIN (National Institute of Nutrition)/ICMR (Indian Council of Medical Research), 2009; ; CDC (Centers for Disease Control & Prevention)-National Health Statistics Reports- Vital & Health Statistics, 2008, 2009 & 2012; McDowell, M. A. et al., 2009; Fryar, C. D. et al., 2012; NIN (National Institute of Nutrition)/ICMR (Indian Council of Medical Research)/NCHS (National Center for Health & Statistics), 2004 & National Nutrition Monitoring Bureau (NNMB), 2002; Indian Council of Medical Research (ICMR), 1972 & 1984; Snyder, R. G. et al., 1977; Snyder, R. G. et al., 1975; Malina, R. M. et al., 1973 & Sharma, J. C., 1970].

Nutrient intake:

Precise information on dietary intake of subjects was gathered through 24 hour's dietary recall method for three consecutive days (three day's dietary recall). This was done to collect very accurate information about the quantity of foods consumed by the basketballers. The data about food intake from their first meal of the after arising in the morning till the last meal consumed before bed time was collected. Information about inclusion of type and quantity of cereals, millets, pulses, legumes, vegetables (roots, tubers, green leafy and other), fruits, milk and its products, nuts, oil seeds, dry fruits, fats and oils, sugars, eggs, non-vegetarian foods (meat, chicken, fish, sea foods etc). Based on 24 hour's dietary recall method for consecutive three days, nutritive values of diets consumed by the players were computed using the food composition tables given by Gopalan, C. et al. (2012) and Longvah, T. et al. (2017). Energy and macro-nutrients were calculated. Actual nutrient intake values of basketball players were compared with recommended dietary allowances (RDAs) (National Institute of Nutrition (NIN)/Indian Council of Medical Research (ICMR), 2009).

Statistical analysis:

Obtained data for basketballers were compared with the standards and recommended dietary allowances (RDAs). Percentage excess or deficit was calculated. Between and within group comparisons were done.

Mean and standard deviation along with minimum and maximum values were drawn and percentages were calculated for various parameters for female and male basketballers from age groups 10-12 yrs and 13-15 yrs.

z test: For females and males (for each age group) comparison between data and standards/RDAs was done using one sample z test. This large sample test (independent samples test) was used to assess the significance of the difference between sample mean and standard/RDA. Comparisons were done for hand measurements, nutrient intake and hand grip strength physical fitness parameters.

Two sample z test was used for within gender group comparisons. Female basketballers from age group 10-12 yrs were compared with those from age group 13-15 yrs whereas male basketballers from age group 10-12 yrs were compared with those from age group 13-15 yrs. This was done to see effect of age on various parameters.

To assess effect of gender on hand grip strength, between gender comparisons were done using two sample z test. For this, female basketballers from age group 10-12 yrs were compared with male basketballers from age group 10-12 yrs. Similarly, female basketballers from age group 13-15 yrs were compared with male basketballers from age group 13-15 yrs.

Critical value of z was tested at both 0.01 and 0.05 levels of significance (1.96 and 2.58, respectively).

Pearson's coefficient of correlation test: Pearson's product moment coefficient of correlation method was used to derive relationship between various parameters for each age group of female and male basketballers. Within group strength of relationship between various measures was assessed. A level of significance at both 5% (0.05) and 1% (0.01) levels was assumed to draw conclusions.

RESULTS AND DISCUSSION:

Anthropometric measurements:
Height, weight and BMI:

Table 1 shows the data on standing height, weight and body mass index of basketballers.

Table 1: Data on Standing Height, Weight and Body Mass Index of Basketballers

Sr. No.	Parameters	GIRLS			BOYS		
		Age Group 10-12 Yrs (n=100)	Age Group 13-15 Yrs (n=100)	z Value¶	Age Group 10-12 Yrs (n=100)	Age Group 13-15 Yrs (n=100)	z Values¶
1	**Standing Height (cm)**						
i	**M±SD**	143.15±7.08	154.62±5.75	**12.57***	140.81±7.64	155.27±10.7	**10.99***
ii	**Range**	128-162	141-167		128-168	135.5-194	
iii	**Standards**	145.1	156.53		145.3	162.1	
iv	**% Deficit**	-1.34	-1.22		-3.09	-4.21	
v	**z Values#**	**2.75***	**3.32***		**5.87***	**6.39***	
2	**Weight (kg)**						
i	**M±SD**	37.36±7.43	47.11±7.15	**9.46***	36.1±8.81	44.51±9.12	**6.63***
ii	**Range**	25-56	35-69		22-62	28-76	
iii	**Standards**	35.00	46.6		34.3	47.6	
iv	**% Deficit /Excess**	+6.74	+1.09		+5.24	-6.49	
v	**z Values#**	**3.17***	**0.71**		**2.04****	**3.39***	
3	**BMI (kg/m²)**						
i	**M±SD**	18.18±3.07	19.66±2.40	**6.63***	18.06±3.32	18.41±2.89	**0.78**
ii	**Range**	12.49-26.34	15.30-27.64		12.20-28.36	12.25-27.52	
iii	**Standards**	16.57	19		16.2	18.1	
iv	**% Excess**	+9.72	+3.47		+11.48	+1.71	
v	**z Values#**	**5.23***	**2.73***		**5.61***	**1.06**	

¶ - z values are for between group comparison (i.e. comparison between age groups 10-12 yrs & 13-15 yrs); # - z values are for comparison between data of subjects & standards; * - Significant at both 5 % & 1% levels ($p<0.01$); ** - Significant at 5 % level but insignificant at 1 % level ($0.01<p<0.05$); Values without any mark indicate insignificant difference at both 5% & 1% levels ($p>0.05$).

Height:

The size and abilities of the modern basketball players are found to differ from that of the early years. A tremendous change in the average height of the players is seen. The short fast players have been replaced by towering six and half footers, who can hand the ball into the basket more easily, due to their abnormal reach. The average height of the present basketball players is more than that of other older sportsmen. The tendency towards tall and physically fit players are still growing (Singh, K. and Ram, M., 2013).

From Table 1, mean values of height for girls from age groups 10-12 yrs & 13-15 yrs and boys from age groups 10-12 yrs & 13-15 yrs were recorded as 143.15±7.08 cm, 154.62±5.75 cm, respectively and 140.81±7.64 cm and 155.27±10.7 cm, respectively. Yener, B. et al. (2007) analysed the somatotype and body composition characteristics of 37 female basketball players (13.84±4.34 yrs) from Et-Balik Sports Club, Turkey, & they found the mean height of the players as 162.2±11.6 cm.

Taller players are often thought to have an advantage in basketball because their shots have less distance to travel to the basket, they start out closer to the rebound, and their ability to reach higher into the air yields a better chance of blocking shorter player's shots (https://en.wikipedia.org/wiki/Height_in_sports). From Table 1, it can be noted that the male basketballers were as tall as 194 cm as compared to the tallest female players of height 167 cm. The closer a tall person is to the basketball goal, the more accurate the shot can be and the less force one applies to propel the basketball into the basket. This is one of the reasons why basketball players must be tall. Looking at the mean values of heights of the players, it was observed that female & male players from age groups 10-12 & 13-15 yrs were shorter in height when matched with their standards by 1.34%, 1.22%, 3.09% and 4.21% for girls from age groups 10-12 yrs, 13-15 yrs and boys from age groups 10-12 yrs, 13-15 yrs respectively. Results of the comparison between recorded mean data of player's height and standards were found to be significant at both 5 % & 1% levels ($p<0.01$) with z values of 2.75, 3.32, 5.87 and 6.39, respectively for girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs.

Patil, S. S. et al., (2013) observed progressive increase in mean height with age in 259 boys aged 10-15 yrs from a city of Karad, Maharashtra However, they noted that in girls (n=192, age=10-15 yrs), the trend for progressive increase in mean height lasts up to 13 years & during 11-12 yrs of age, girls had higher mean height by 1.69 to 4.69 cm as compared to boys of that age (p=0.021). At 14 yrs of age, the boys were taller by 2.1 cm & at 15 yrs 12.3 cm than the counterpart girls, respectively. This is because in boys, adolescent growth continues for a longer period. At the age 14.5 & 15 years mean height was significantly (p=0.000 and p=0.006 respectively) higher in boys compared to girls. Similarly, for the present research, based on the mean height values as seen from Table 1, younger female basketballers were found to be taller than younger male basketballers of same age group. Girls from age group 10-12 yrs were found to be exceeding by 2.34 cm than boys from same age group. As far as older age group (13-15 yrs) is considered, not much difference was found in the mean heights of female & male basketballers.

Greene, J. J. et al. (1998) studied varsity basketball teams at high schools & noted that the male subjects (n=61) were found to be significantly taller than the female subjects (n=54). Tomovic, M. et al. (2016) determined anthropometric parameters in 335 elite male basketball player in USA (21.57±4.58 yrs) and categorized according to their positional roles as guards (n=156), forwards (n=48), and centres (n=131). The height (guards: 187.52±6.05 cm, forwards: 195.20±3.45 cm, centres: 208.71±4.63 cm) were found to be different between all three groups (p<0.001). Studies on anthropometric measurements among basketballers aged 10-15 yrs based on their playing positions are not done exclusively & are in need to see the differences for this.

For the present research when comparison was made between female basketballers aged 10-12 yrs with female basketballers aged 13-15 yrs as well as between male basketballers aged 10-12 yrs with male basketballers aged 13-15 yrs, it was seen that older groups of basketballers were found to be significantly taller than younger groups (z=12.57 and 10.99 respectively for girls aged 10-12 yrs vs. 13-15 yrs and boys aged 10-12 yrs vs. 13-15 yrs, p<0.01).

Weight:

The game of basketball is fast paced and very racy, every move at every second counts. Player needs a body that sustains the high energy impact this game requires. It's not about being skinny or fat, it's about gaining weight the healthy way, after all player don't want to be pushed down or manhandled when she/he is dribbling the ball or passing it on to a team mate. Basketballers need the energy, strength and most importantly the weight to sustain the pushes, nudges and the roughness of the game (http://www.layups.com/gaining-weight-as-a-basketball-player/).

Table 4.3 shows the data on body weight of basketballers. The mean values of body weight of players increased with the age, having mean values as 37.36±7.43 kg, 47.11±7.15 kg, 36.1±8.81 kg and 44.51±9.12 kg for girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs, respectively. Female players from age groups 10-12 yrs were found to be heavier than the male players from age group 10-12 yrs whereas female players from age groups 13-15 yrs were found to be heavier than the male players from age group 13-15 yrs. This can be attributed to gender differences in growth pattern.

Yener, B. et al. (2007) analyzed the somatotype and body composition characteristics of 37 female basketball players (13.84±4.34 yrs) from Et-Balik Sports Club, Turkey, & they found the mean weight of the players as 55.4±15.7 kg.

With the exception of older age group of boys (13-15 yrs), rests of the groups of female & male basketballers were found to be heavier than the reference standards of body weights. The excess weight gain was more prominent among younger players. For girls aged 10-12 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs, pair z test values for the comparison between mean body weights of subjects & standards showed significant differences at both 5 % & 1% levels (z=3.17, 2.04 & 3.39, respectively, p<0.01) and these three groups of basketballers depicted 6.74, 1.09 & 5.24% excess of mean body weights as compared to standards. In contrast to this, older boys from age group 13-15 yrs had mean body weight significantly below the standard (z=3.39, p<0.01, Table 1). This could be attributed to fast gain in the height owing to growth. Female basketballers from 10-12 yrs age group were found to be heavier than male basketballers from 10-12 yrs age group. Similar trend was noted between female & male basketballers from age group 13-15 yrs.

When within gender comparisons were made between the two age groups i.e. 10-12 yrs and 13-15 yrs, it was noted that older female basketballers were heavier than younger female basketballers (z=9.46, p<0.01). Similar results were obtained for comparison between older & younger male basketballers for their mean body weights (z=6.63, p<0.01, Table 1).

Irrespective of age and gender, strong positive correlation was found between weight and height of all the groups of players (r=0.5253 to 0.6379, p<0.01). The correlations were stronger in male players than female players. As one grows in height, weight should also increase. Prajakta, N. (2010) noted high positive correlation between height and weight among 37 young female swimmers, aged 10-14 yrs (r=0.58 to 0.92, p<0.01 for 10+, 11+ & 12+ yrs & p>0.05 for 13+ & 14+ yrs).

Body Mass Index (BMI):

The body mass index depends not only on the fat content in the human body, but also on the muscle and bone mass as well as on the water content in the body of athletes. High value of the BMI can be estimated as overweight in athletes with great skeletal muscles mass. It means that training in many sports specializations causes increase of the body mass index (Daskalovski, B.et al., 2013; McArdle, W. D. et al., 2007 & Ode, J. J. et al., 2007).

Mean values of BMI (Table 1) were recorded as 18.18±3.07 kg/m², 19.66±2.40 kg/m², 18.06±3.32 kg/m² and 18.41±2.89 kg/m² for girls aged 10-12 yrs, girl aged 13-15 yrs, boys aged 10-12 yrs and boys aged 13-15 yrs, respectively. Minimum and maximum BMI ranged from 12.49-26.34, 15.30-27.64, 12.20-28.36 and 12.25-27.52 kg/m² for girls aged 10-12 yrs, girl aged 13-15 yrs, boys aged 10-12 yrs and boys aged 13-15 yrs, respectively.

Daskalovski, B. et al. (2013), in a research conducted on a sample of 30 basketball players stated that the value of BMI in 14 aged basketball players ranged from 16.90 to 26.40 kg/m² and averages 21.94 kg/m². In older basketball players (15 years) value of BMI ranged from 18.60 to 25.96 kg/m² or an average of 21.52 kg/m². Both average values of BMI were 75 percentile.

The differences between the standard reference values of BMI and the mean BMI values for 10-12 yrs old girls, 13-15 yrs old girls & 10-12 yrs old boys under this study were significant at both 5% & 1% levels. All these three groups of basketballers surpassed the standards for their BMI significantly (z=5.23, 2.73 & 5.61, respectively, $p<0.01$). However, this difference was insignificant for 13-15 yrs old boys (z=1.06, $p>0.05$). Younger group of boys showed higher % excess (11.48) followed by younger group of girls (9.72), then by older group of girls (3.47) & lastly by older group of boys (1.71). A more muscular player might have a higher weight and BMI but not have too much body fat. A smaller player could have an ideal BMI, but might have less muscle and too much body fat.

For this study, there found increasing trend in the BMI with increase in the age, with older groups of female & male basketballers possessed higher mean BMI than their younger counterparts; the difference was statistically significant for the comparison between younger & older groups of females (z=6.63, $p<0.01$) but insignificant for the comparison between younger & older groups of males (z=0.78, $p>0.05$) (Table 1). It is very common for adolescents to gain weight quickly and the BMI goes up during puberty.

Younger group of gymnasts (boys; n=100; 10-12 yrs) studied by Deshpande, P. & Nande, P. (2016) showed significantly greater BMI than the standard for age (z=8.97, $p<0.01$) with % excess of 15 whereas they reported that older age group of gymnasts (boys; n=100; 13-15 yrs) showed insignificantly lower BMI than the standard for age (z=1.68, $p>0.05$) with % deficit of 2.59.

Figure 1 shows the percentage wise distribution of basketballers based on BMI.

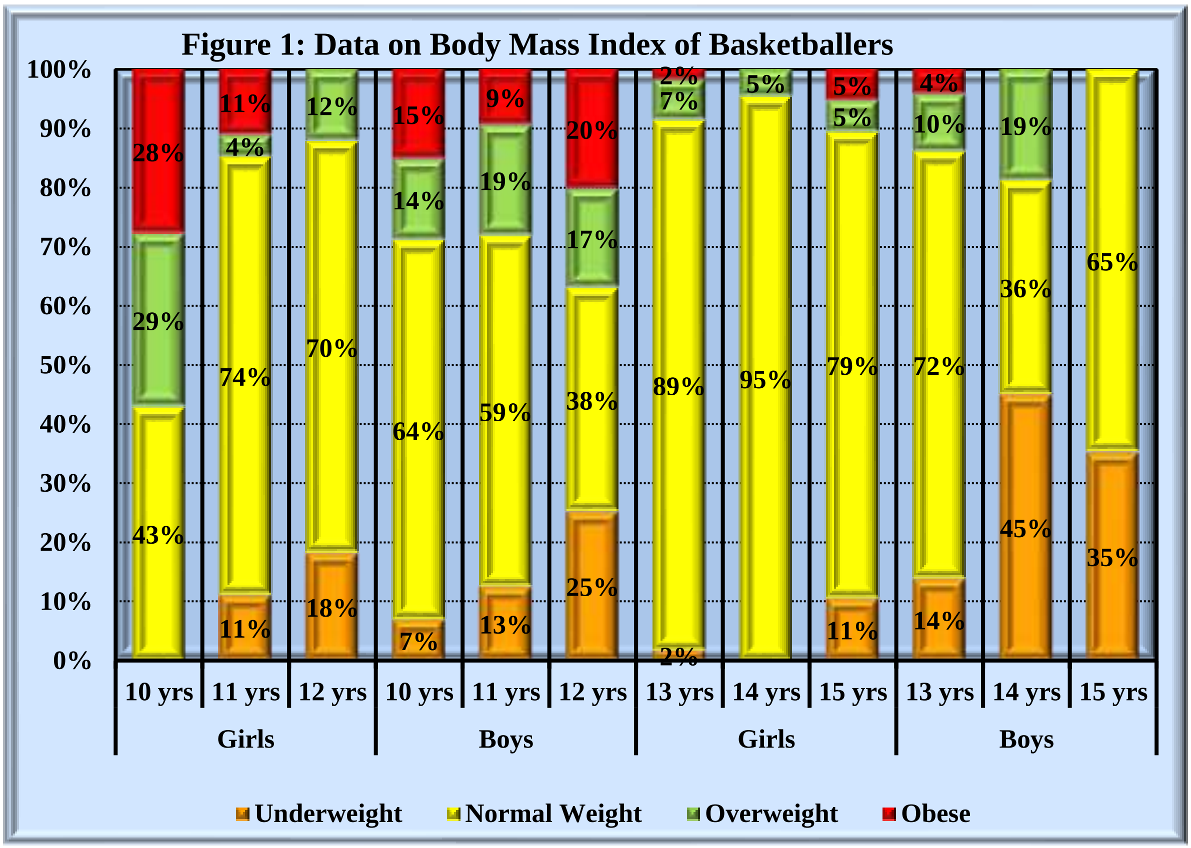


Figure 1: Data on Body Mass Index of Basketballers

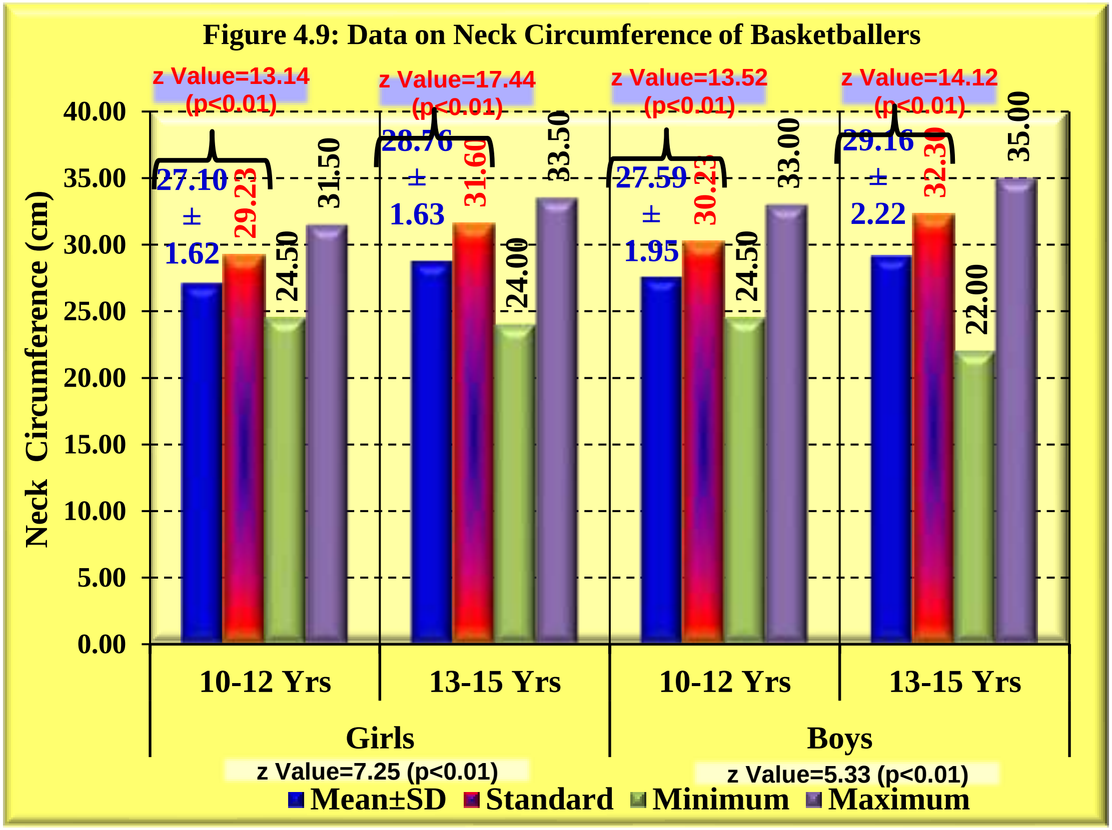
In comparison to boys, % of obese girls was higher. The prevalence was more predominant among younger girls than older girls as also seen from Figure 4.2.

Based on percentile distribution of BMI, Daskalovski, B.et al. (2013) found that 40% younger basketball players had a BMI of 95th percentile whereas in older (15 years) group, all basketball players had a BMI percentile distribution of 50 to 95 percentile.
Figure 1 clearly depicts that percentage of normal weight basketballers was more prominent in female players (43-95%) than male basketballers (36-72%). 7-45% male players were found to be underweight for their BMI whereas 7-18% female players were found to be underweight.
4-29% girls & 14-19% boys from age groups 10-12 yrs were rated as overweight whereas 5-28% girls & 9-20% boys from age groups 13-15 yrs were rated as overweight which indicate weight gain due to pubertal changes.
With the exception of older boys, girls aged 10-12 yrs & 13-15 yrs & boys aged 10-12 yrs depicted direct relationship with height (r=0.0269 to 0.2601). The reason of having negative correlation of BMI with height in older boys may be increase in height which might have reduced BMI.
Among girls & boys aged 10-12 yrs & 13-15 yrs under this study, there found very strong, positive & significant correlation of BMI with body weight (r=0.8605, 0.8760, 0.8926 & 0.7094, respectively for girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs, p<0.01).
Deshpande, P. & Nande, P. (2016) studied 200 male gymnasts & they stated that BMI reflected direct relationship with weight among gymnasts from age group 10-12 yrs & 13-15 years (r=0.8430 & 0.8419, respectively, p>0.05)
More insight for young female & male sport persons is required as far as BMI is concerned.

Neck Circumference:

Neck circumference measurement is a simple screening measure, as an index of upper body fat distribution that can be used to identify overweight and obese people & is identified as an index of central obesity (Saka, M. et al., 2014; Arnold, T. J. et al., 2014; Nafiu, O. O. et al., 2010; Arie, L. & Liubov, B. N., 2004 & Liubov, B. N. et al., 2001).
The neck musculature has an essential role in positioning and stabilizing the head and may influence sport performance and injury risk (Hrysomallis, C., 2016). The strength of the neck can also impact the respiratory system and the quality of breathing as several of the neck muscles assist in respiration, especially during demanding exercise. Stronger neck muscles improve sport's performance. A stronger neck can thus improve balance and locomotion, both of which are important aspects of every sporting and fitness activity (https://www.technogym.com/int/wellness/the-neck-the-power-behind-the-head/).

Figure 2 presents data on neck circumference of basketballers.



Girls from 10-12 yrs & 13-15 yrs age groups and boys from 10-12 yrs & 13-15 yrs age groups showed the mean values for neck circumference as 27.10±1.62 cm, 28.76±1.63 cm, 27.59±1.95 cm and 29.16±2.22 cm, respectively. Neck circumference increased with the age in both the genders and found to be higher in older players. Mean values of neck circumference in basketballers when compared to their standards found to be significantly less (z=13.14, 17.44, 13.52 & 14.12, respectively for girls aged 10-12 yrs & 13-15 yrs & boys aged 10-12 yrs & 13-15 yrs, p<0.01). Muscular neck is one of the important characteristics of athletes which show the sturdiness.

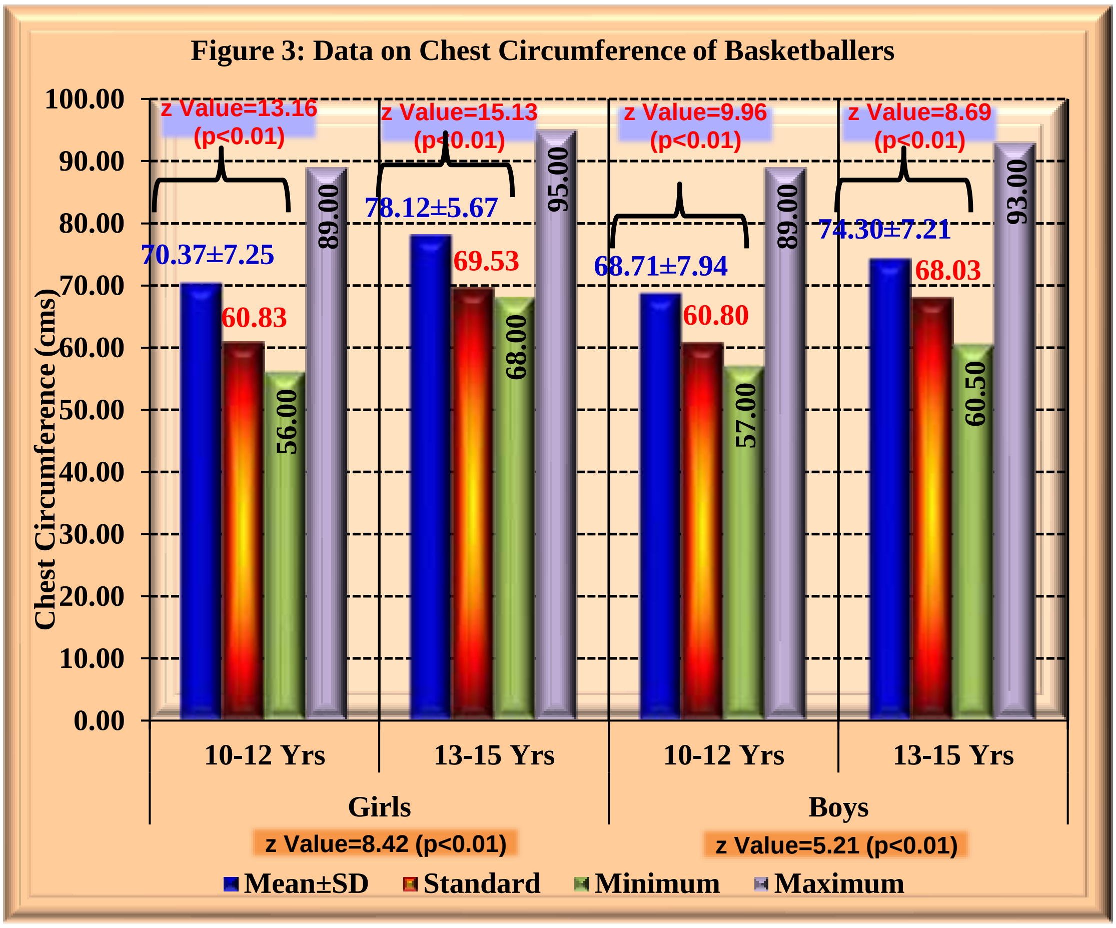
The groups of older girls and boys showed significantly larger mean neck circumference than the groups of younger girls and boys, respectively which clearly indicate effect of age & sports training (z=7.25 for girls aged 10-12 yrs vs. girls aged 13-15 yrs and z=5.33 for boys aged 10-12 yrs vs. boys aged 13-15 yrs p<0.01). Based on mean values, older boys possessed larger neck circumference than older girls. Similar result was seen for younger groups of girls & boys as also seen in Figure 2. Mazicioglu, M. M. et al. (2010) studied the neck circumference in Turkish children aged 6-18 years and found that the neck circumference of boys was greater, but not significantly higher, than that of girls until the age of 12 but later a prominent increase in the neck circumference of boys is observed as compared with girls. Lou, D. H. et al. (2012) in population-based study of 2847 Han children aged 7-12 yrs found the mean neck circumference in boys significantly greater than in girls (29.2±3.1 cm vs. 28.1±2.8 cm, p<0.001).

For this study, neck circumference showed significant (p<0.01) & positive correlation with standing height (r=0.3778 to 0.5345). Among girls & boys aged 10-12 yrs & 13-15 yrs, the correlation of neck circumference with weight (r=0.8410, 0.7781, 0.8793 & 0.7676, respectively) and BMI (r=0.7586, 0.6780, 0.8121 & 0.6072, respectively).

Chest Circumference:

The purpose to measure the circumference of the chest is to assess measure of the chest muscles and lung size. The lungs, heart and blood vessels perform a vital function as the body's supply system. They supply the muscles with the necessary fuels and oxygen, and carry away waste products such as carbon-dioxide and lactic acid. Consequently, the cardiorespiratory system in the athlete needs to be developed to match the muscles which it supplies and cleanses. It is believed that bigger the lungs and heart size greater will be the cardio-respiratory efficiency (Shivani & Tripathi, A. K., 2017). The chest circumference measurement is an important growth index in sports. The relationship of the chest circumference to the person's stature indicates the tendency to grow in width or height. This correlation also reveals whether or not a person is barrel-chested (https://athlometrix.com/en/ chest-circumference/).

Figure 3 shows the data on chest circumference of basketballers.



For this study, mean values for chest circumference in subjects were recorded as 70.37±7.25 cm, 78.12±5.67 cm, 68.71±7.94 cm and 74.30±7.21 cm in girls aged 10-12 yrs & 13-15 yrs and boys aged 10-12 yrs & 13-15 yrs, respectively.
Nande, P. et al. (2008) studied anthropometric profile of female and male players engaged in different sports disciplines and found mean chest circumference values for female players in the range of 80.0 to 91.0 cm. Among male players, judo group had highest value of mean chest circumference (89.2±4.2 cm) whereas volleyball group had lowest value of mean chest circumference (82.2±2.4 cm).

The study of Mohamed, A. N. I. (2012) showed a value of chest circumference as 114.84±15.07 cm for junior level volleyball players and a value of chest circumference as 114.84±15.07 cm for junior level handball players. In the present study, all the groups of basketballers possessed significantly greater (z=8.69 to 15.13, p<0.01) mean chest circumference than standards for their age and gender. When mean values of chest circumference of younger girls & boys were compared with older girls & boys respectively, it was noted that the older groups possessed significantly greater girth values than younger groups (z=8.42 & 5.21 respectively, p<0.01). Chest circumference represented significant and positive correlation with standing height (r=0.3662 to 0.5048), weight (r=0.7637 to 0.9177), BMI (r=0.7215 to 0.8847) and neck circumference (r=0.7259 to 0.8854) in basketballers from all four age groups.

Waist and Hip Circumference:

The circumference of the waist is important in athletes because it is a good indicator of how much abdominal, or visceral, fat they have - the fat they carry around the middle, including belly. Waist circumference is less affected by factors like height and muscularity compared to other measures like BMI (https://www.abc.net.au/news/health/2017-09-06/waist-size-why-it-matters-and-when-its-a-risk/8839708). A basketball player's ability to pivot and jump comes down to the strength and flexibility of the hips. Yet, the hips are often overlooked as one of the body's most important sources of power and force, especially in athletes. Many people don't know that the hips carry most of the weight. The hip joint where the upper end of the thigh bone meets the pelvis is associated with over 15 muscles including the hip flexors, extensors, rotators, abductors and adductors. Decreased mobility in this joint can make simple moves like squatting or scooping up a ball feel like a herculean task. Hip pain or lack of mobility is often the result of repetitive overuse in sports that require a lot of jumping and twisting, as well as poor body movements (http://www.philly.com /philly/blogs/sportsdoc/Your-hips-and-your-athletic-performance.html).
Table 2 shows data on waist circumference and hip circumference of basketballers.

Table 4.11: Data on Waist Circumference and Hip Circumference of Basketballers

Sr. No.	Parameters	GIRLS			BOYS		
		Age Group 10-12 Yrs (n=100)	Age Group 13-15 Yrs (n=100)	z Values ¶	Age Group 10-12 Yrs (n=100)	Age Group 13-15 Yrs (n=100)	z Values ¶
1	**Waist Circumference (cm)**						
i	**M±SD**	68.29±8.52	72.95±7.37	**4.14***	67.32±10.26	69.81±8.49	**1.87**
ii	**Range**	52.00-87.00	59.00-94.50		52.00-100.00	52.00-90.00	
iii	**Standard**	72.57	79.90		71.90	78.83	
iv	**% Deficit**	-5.90	-8.70		-6.37	-11.44	
v	**z Values#**	**5.03***	**9.44***		**4.47***	**10.63***	
2	**Hip Circumference (cm)**						
i	**M±SD**	77.18±8.35	87.19±6.42	**9.51***	75.08±8.64	80.06±7.25	**4.22***
ii	**Range**	43.50-95.00	75.50-105.00		53.00-98.00	66.00-98.00	
iii	**Standard**	80.83	92.77		78.43	89.53	
iv	**% Deficit**	-4.52	-6.01		-4.27	-10.58	
v	**z Values#**	**4.38***	**8.70***		**3.88***	**13.06***	

¶ - z values are for between group comparison (i.e. comparison between age groups 10-12 yrs & 13-15 yrs); # - z values are for comparison between data of subjects & standards; * - Significant at both 5 % & 1% levels (p<0.01); ** - Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); Values without any mark indicate insignificant difference at both 5% & 1% levels (p>0.05).

The recorded mean values from Table 2 for waist circumference in basketballers were as 68.29±8.52 cm, 72.95±7.37 cm, 67.32±10.26 cm and 69.81±8.49 cm in girls aged 10-12 yrs & 13-15 yrs and boys aged 10-12 yrs & 13-15 yrs, respectively, whereas it was 77.18±8.35 cm, 87.19±6.42 cm, 75.08±8.64 cm and 80.06±7.25 cm, respectively for hip circumference. The mean values were higher in girls from both the age groups for both the measurements as women typically accumulate fat around lower abdomen and pelvis owing to pubertal changes in this age.
In a study conducted by Nande, P. et al. (2008) on young female and male players aged 18- 22 yrs engaged in different sports disciplines; female players showed higher mean values for waist circumference as compared to males with mean value to be ranged between 83.0 to 90.0 cm in female players (the highest value for half marathon & the lowest value for badminton) whereas means were found to be in the range of 76.5 to 81.5 cm

among males with fewer differences in different sports disciplines. In the same study by Nande, P. et al. (2008), females had mean hip circumference ranged between 91.0 to 97.0 cm (lowest value for badminton & highest value for hurdle racing). Fewer differences were observed for mean hip circumference among male players. Highest mean hip circumference was recorded for athletics (93.3 cm) & that of lowest for badminton (88.7 cm) for males.

When mean values of waist circumference and hip circumference of subjects were compared with the reference standards, all the groups of female & male basketballers possessed significantly lower waist circumference (z=4.47 to 10.63, p<0.01) as well as lower hip circumference (z=3.88 to 13.06, p<0.01). The players failed to match the standards by 5.90% to 11.44% for waist circumference and 4.27% to 0.58% for hip circumference (Table 2). Singh, K. and Ram, M. (2013) stated that the optimum development of hip muscle girth contributes to improved jumping capacity of players in the game of basketball.

Older girls showed significantly higher mean waist circumference & hip circumference than younger girls (z=4.14 & 9.51, respectively, p<0.01). However, even though older boys possessed higher mean waist circumference than younger boys, the difference was insignificant at both 5% & 1% levels (z=1.87, p>0.05). This clearly shows impact of sports training. However, older boys showed significantly larger mean hip circumference than younger boys (z=4.22, p<0.01).

For the present research, waist circumference and hip circumference was found positively correlated with standing height (r=0.2450 to 0.5849). Any gain in the girth measure also add weight, here also, waist & hip circumferences among all four age groups of basketballers showed significant (p<0.01) & positive correlation with weight (r=0.6896 to 0.9257), BMI (r=0.6551 to 0.8504), neck circumference (r=0.6083 to 0.8596) and chest circumference (r=0.6914 to 0.9121). A strong positive Pearson correlation of neck circumference with waist circumference was found in both male and females (r=0.64 in male and r=0.86 in female, respectively) in a cross sectional observational study of total 297 (147 male and 150 female) participants, aged above 18 years conducted on 2013 at Kathmandu valley by Karki, B. B. et al. (2015). Nafiu, O. O. et al. (2010) reported in children aged 6-18 yrs that waist circumference was significantly correlated with neck circumference in both boys and girls, although the correlation was stronger in older children.

Nutrient intake:

Energy demands during the basketball season are substantial and may be even higher during off-season training. Choosing foods that provide the energy to support competition and training is essential and can also be quite challenging. Although total energy intake is important to counteract weight loss during the season, the source of the calories is critical to provide the muscle with the right type of fuel. The body's preferred fuel during high-intensity activities such as basketball is carbohydrate. Basketball players should consume a high-carbohydrate diet; that is to say that at least 55-65% of total calories in the diet should come from food rich in carbohydrate such as cereals, millets, sugars, starches, fruits, vegetables, etc. The range of carbohydrate intake suggested for basketball players is 5-7 (and up to 10) g/kg body weight depending upon playing time and the time of year (preseason, in-season, or postseason). Protein is very important nutrient for actual athletic performance. A sufficient protein intake is important for the building of muscle mass and the recovery of damaged tissues. It is generally known that an increased need for protein is found in children and adolescent athletes because as they start with regular physical training, muscle mass builds up. The recommendation for daily protein intake for basketball players is 1.4-1.7 g/kg of body weight. Besides protein & carbohydrates, dietary fats are important for the synthesis of hormones and cell membranes, as well as proper immune function. Athletes should strive to eat heart-healthy fats such as mono-unsaturated fats as well as omega-3 fats and avoid saturated fats and trans fats present in processed foods. Energy intake from fat should make up the remainder of calories after protein and carbohydrate recommendations are met. The role of nutrition in sports performance is very important. Proper nutrition must be available prior, during and post competition (Osterberg, K., 2017 and Indoria, A. and Singh, N., 2016).

Data on daily mean intake of energy, carbohydrates, protein and fat by basketballers is demonstrated in Table 4.

Irrespective of the age and gender, all the groups of players had lower mean daily intake of energy than RDAs (1865±282 kcal, 2242±204 kcal, 2181±159 kcal and 2479±183 kcal in girls from 10-12 yrs, 13-15 yrs age groups and boys from 10-12 yrs, 13-15 yrs age groups, respectively). Deficit intake of energy can lead to compromised work capacity.

Table 4: Data on Daily Mean Intake of Energy, Carbohydrate, Protein and Fat by Basketballers

Sr. No.	Parameters	GIRLS			BOYS		
		Age Group 10-12 Yrs (n=100)	Age Group 13-15 Yrs (n=100)	z Values¶	Age Group 10-12 Yrs (n=100)	Age Group 13-15 Yrs (n=100)	z Values¶
1	**Energy (kcal)**						
i	**M±SD**	1865±282	2242±204	**10.88***	2181±159	2479±183	**12.27***
ii	**Range**	1280-2359	1521-2714		1792-2557	2000-2806	
iii	**RDA**	2010	2330		2190	2750	
iv	**% Deficit**	-7.24	-3.76		-0.41	-9.87	
v	**z Values#**	**5.17***	**4.31***		**0.57**	**14.80***	

2	**Carbohydrate (g)**						
i	**M±SD**	314.91±55.05	380.37±33.90	**10.12***	372.79±26.05	411.08±35.04	**8.77***
ii	**Range**	188.26-404.89	242.80-455.55		311.63-430.82	311.74-471.41	
3	**Protein (g)**						
i	**M±SD**	48.41±7.57	58.84±7.22	**9.97***	56.90±5.90	64.02±5.00	**9.21***
ii	**Range**	29.99-64.24	37.31-72.54		41.52-68.51	52.93-72.64	
iii	**RDA**	40.40	51.90		39.90	54.30	
iv	**%Excess**	+19.83	+13.37		+42.61	+17.90	
v	**z Values#**	**10.58***	**9.62***		**28.82***	**19.44***	
4	**Fat (g)**						
i	**M±SD**	45.69±6.49	53.94±7.97	**8.03***	51.35±6.30	64.26±5.79	**15.09***
ii	**Range**	35.07-60.63	37.79-72.41		37.67-66.29	51.41-78.21	

¶ - z values are for between group comparison (i.e. comparison between age groups 10-12 yrs & 13-15 yrs); # - z values are for comparison between data of subjects & standards; * - Significant at both 5 % & 1% levels ($p<0.01$); ** - Significant at 5 % level but insignificant at 1 % level ($0.01<p<0.05$); Values without any mark indicate insignificant difference at both 5% & 1% levels ($p>0.05$).

Nande, P. et al. (2008) assessed energy intake and expenditure in 59 players (13 female & 46 male players), aged 18-22 years, engaged in different sports disciplines such as athletics, volleyball, cricket, judo, gymnastics, weight lifting, hurdle racing, half marathon, badminton, cross country etc. and found that irrespective of the sport group, female players (t=3.62, p<0.01) and male players (t = 8.05, p<0.01) showed mean intakes of energy below their respective RDA's. Cabral, C. A. C. et al. (2006) aimed to diagnose the nutritional status of the 24 athletes from weight lifting permanent Olympic team of the Brazilian Olympic Committee, aged 16-23 yr, 12 males (19.7±2.4 yr) and 12 females (19.2±1.8 yr) and in the study, 83% of the athletes presented energy intake below the recommended values, considering the high level of physical activity, resulting in daily caloric deficiency.

For the present research, the mean energy intake by younger group of boys was found to be greater than that of younger girls. Similarly, mean energy intake by older group of boys was found to be greater than that of older girls. A difference of 316 kcal was observed between the mean intake of energy intake by girls and boys aged 10-12 yrs whereas it was 237 kcal in case of girls and boys aged 13-15 yrs. Older group of female players consumed significantly higher amounts of energy than younger group of female players (z=10.88). Similarly, older group of male players consumed significantly higher amounts of energy than younger group of male players (z=12.27). The mean energy intake among girls (10-12 yrs), girls (13-15 yrs), boys (10-12 yrs) and boys (13-15 yrs) was calculated as 49.91, 47.59, 60.41 and 55.69 kcal/kg actual mean body weight/day, respectively. Majority of basketballers consumed daily energy intake below RDA. Unfortunately, 71% of 13-15 yrs aged male basketballers were found to have energy intake below RDA followed by 52% of 10-12 yrs aged girls, 50% of 13-15 yrs aged girls and then 31% of 10-12 yrs aged boys. 21%, 31%, 50% and 24% of girls from 10-12 yrs and 13-15 yrs age groups and boys from 10-12 yrs and 13-15 yrs age groups respectively consumed adequate intake of energy in their diets. Also, 5%, 19%, 19% and 27% of girls (10-12 yrs), girls (13-15 yrs), boys (10-12 yrs) & boys (13-15 yrs) respectively showed daily energy intake above RDAs.

Mean carbohydrate intake by girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs was 314.91±55.05, 380.37±33.90, 372.79±26.05 and 411.08±35.04 g, respectively which was found to be increased with age in both the genders. The mean intake of carbohydrate in girls aged 13-15 yrs was higher by 65.46 g than in girls aged 10-12 yrs (z=10.12) whereas it was higher by 38.29 g in boys aged 13-15 yrs as compared to boys aged 10-12 yrs (z=8.77). This is because older groups in both genders had higher energy intake and a major portion of energy came from carbohydrate in their diets. The mean intake of carbohydrate per kg actual body weight was calculated as 8.42, 8.07, 10.32 and 9.23 g/kg/day for girls aged 10-12 yrs and 13-15 yrs and boys aged 10-12 yrs and 13-15 yrs, respectively.

Mean values of daily protein intake for all the groups of basketballers were found to be significantly higher than RDAs (z=10.58, 9.62, 28.82 and 19.44, respectively for girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs and boys aged 13-14 yrs, p<0.01). The mean values for daily protein intake were recorded as 48.41±7.57 g, 58.84±7.22 g, 56.90±5.90 g and 64.02±5.00 g with % excess (in comparison with RDAs) of 19.83, 13.37, 42.61 and 17.90 %, respectively for girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs. In comparison to girls, boys showed far higher mean protein intake than RDAs which was clearly reflected from z values (Table 4).

The difference in the mean intake of protein by younger & older groups of girls i.e. 10-12 yrs and 13-15 yrs was found to be 10.43 g whereas the difference was 7.12 g between younger & older groups of boys i.e. 10-12 yrs and 13-15 yrs. The older groups of girls & boys showed significantly higher mean daily intake of protein than younger groups of girls & boys (z=9.97 for girls aged 10-12 yrs vs. girls aged 13-15 yrs and z=9.21 for boys aged 10-12 yrs vs. boys aged 13-15 yrs)(p<0.01). The mean protein intake per kg body weight per day was derived as 1.29 g, 1.24 g, 1.57 g and 1.43 g, respectively for girls aged 10-12 yrs, girls aged13-15 yrs, boys aged 10-12 yrs and boys aged 13-15 yrs. Younger group of male basketballers consumed higher mean daily protein than younger group of female basketballers & a difference of 8.49 g was noted between them for mean daily protein intake. Similarly, older group of male basketballer consumed 5.18 g excess mean daily protein than older group of female basketballers. Majority of the basketballers i.e. 36% of girls aged 10-12 yrs , 46% of girls aged 13-15 yrs, 83% of boys aged 10-12 yrs and 75% of boys aged 13-15 yrs consumed excess protein in their diets. 59% girls (10-12 yrs), 49% girls (13-15 yrs), 17% boys (10-12 yrs) and 24% boys (13-15 yrs) had adequate intake of protein whereas 5% from each group of female players and 1% of boys aged 13-15 yrs reported to have protein intake below RDAs.

Similar to protein intake, mean daily intake of fat was also higher in older groups than younger groups of basketballers. The differences in the mean fat intake between 10-12 yrs & 13-15 yrs age groups were recorded as 8.25 g in girls and 12.91 g in boys. Mean fat intake was derived as 45.69±6.49 g, 53.94±7.97 g, 51.35±6.30 g and 64.26±5.79 g, respectively for girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs and boys aged 13-15 yrs. Older age groups of female and male basketballers consumed significantly higher mean daily fat than younger groups of female and male basketballers (z=8.03 for girls aged 10-12 yrs vs. girls aged 13-15 yrs and z=15.09 for boys aged 10-12 yrs vs. boys aged 13-15 yrs, p<0.01). Fat intake in girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs and boys aged 13-15 yrs was found as 1.22, 1.14, 1.42 and 1.44 g/kg/, respectively.

For the present research, among girls (10-12 yrs), girls (13-15 yrs), boys (10-12 yrs) & boys (13-15 yrs), intakes of energy, carbohydrate, protein & fat depicted significant & positive correlations with height (r=0.4486, 0.4647, 0.5847 & 0.3904; 0.3871 for energy intake; r=0.3983, 0.5322 & 0.3455 for carbohydrate intake; 0.4992, 0.3337, 0.3093 & 0.3171 for protein intake and 0.4443, 0.4309, 0.5334 & 0.3230 for fat intake, respectively, p<0.01).

Among girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs, energy intake showed the significantly (p<0.01) strong & positive correlation with weight (r=0.7290, 0.8365, 0.8417 & 0.7249, respectively) and BMI (r=0.5921, 0.7546, 0.7452 & 0.6028, respectively). Carbohydrate intake also exhibited strong positive & significant (p<0.01) correlation with weight (r=0.6915, 0.7797, 0.8093 & 0.6437, respectively) and BMI (r=0.5896, 0.7225, 0.7310 & 0.5357, respectively). Protein intake showed more strong positive & significant correlation in younger group of players with weight (r=0.6699, 0.4957, 0.6021 & 0.4765, p<0.01, respectively in girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs) and BMI (r=0.4815, 0.4232, 0.6166 & 0.3498, p<0.01, respectively in girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs). Fat intake also presented strong positive & significant (p<0.01) correlation with weight (r=0.5599, 0.6997, 0.6228 & 0.6369, respectively) and BMI (r=0.3817, 0.6045, 0.4903 & 0.5463, respectively).

Prajakta, N. et al. (2010) assessed the nutritional status & physical fitness of 37 young female swimmers, aged 10-14 yrs and found positive correlation of intake of energy & three major nutrients with body weight indicating positive effect of food consumption on weight gain. Penggalih, M. H. (2017) studied correlation between dietary intakes with anthropometry profile in 131 youth football athlete in Indonesia and found that intake of energy, fats and carbohydrates had a significant effect on body weight & BMI (p<0.05).

Body girths are highly influenced by dietary intake of energy. In the present study, energy intake depicted highly strong positive & significant correlation with different body girths like neck circumference (r=0.5819, 0.6885, 0.7440 & 0.5676, respectively, p<0.01); chest circumference (r=0.6482, 0.6073, 0.7799 & 0.6872, respectively, p<0.01); waist circumference (r=0.5887, 0.5642, 0.7180 & 0.6290, respectively, p<0.01) and hip circumference (r=0.6201, 0.7890,0.7882 & 0.6755, respectively, p<0.01). Similar to energy intake, among all four groups of basketballers (i.e. girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs), carbohydrate intake reflected strong positive & significant correlations with neck circumference (r=0.5502, 0.6639, 0.7249 & 0.4706, respectively, p<0.01); chest circumference (r=0.6109, 0.5660, 0.7613 & 0.5709, respectively, p<0.01); waist circumference (r=0.5267, 0.5238, 0.7199 & 0.5216, respectively, p<0.01) and hip circumference (r=0.6071, 0.7273, 0.7573 & 0.5782, respectively, p<0.01). Among girls (10-12 yrs), girls (13-15 yrs), boys (10-12 yrs) & boys (13-15 yrs), protein intake also showed moderate to strong correlations which were significant (p<0.01) with neck circumference (r=0.5727, 0.4292, 0.5783 & 0.4077, respectively); chest circumference (r=0.6001, 0.3816, 0.5428 & 0.5322, respectively); waist circumference (r=0.5655, 0.3489, 0.5578 & 0.4336, respectively) and hip circumference (r=0.5653, 0.4892, 0.5753 & 0.4607, respectively). Like other two macronutrients-carbohydrate & protein, fat intake among girls aged 10-12 yrs, girls aged 13-15 yrs, boys aged 10-12 yrs & boys aged 13-15 yrs demonstrated significant positive correlation with neck circumference (r=0.4340, 0.5254, 0.5141 & 0.5754, respectively, p<0.01); chest circumference (r=0.5104, 0.4991, 0.5625 & 0.6787, respectively, p<0.01); waist circumference (r=0.5590, 0.4698, 0.4587 & 0.6445, respectively, p<0.01) and hip circumference (r=0.4071, 0.6663, 0.5798 & 0.6452, respectively, p<0.01). The results of correlates of energy & energy giving nutrients clearly indicate the important role of diet balanced in carbohydrate, protein & fat in attaining required physical dimensions during the period of growth.

CONCLUSION

In conclusion, this correlational study on the anthropometric and nutritional profiles of junior basketball players has provided valuable insights into the physical characteristics and dietary habits of young athletes. The investigation focused specifically on the relationship between body mass index (BMI) and trunk girths, including neck, chest, waist, and hip circumferences, to understand their implications for athletic performance and health outcomes. The findings revealed significant correlations between weight, BMI, trunk girths and energy as well as three major nutrients among junior basketball players, indicating the importance of considering both overall body composition and regional fat distribution in this population. Higher BMI values were associated with increased trunk girths, suggesting a tendency towards greater adiposity and potentially influencing athletic performance and injury risks. Moreover, nutritional analysis highlighted variations in energy and macronutrient intake among participants, underscoring the importance of personalized dietary interventions tailored to the unique needs of young athletes. Adequate energy and macronutrient consumption are essential for supporting the high demands of training and competition, promoting optimal growth, development, and performance in junior basketball players. These findings have practical implications for coaches, trainers, and nutritionists involved in youth basketball programs. By understanding the anthropometric and nutritional profiles of junior athletes, stakeholders can develop evidence-based strategies for training, nutrition, and injury prevention, ultimately enhancing the overall well-being and athletic potential of young basketball players. Moving forward, longitudinal studies and intervention trials are warranted to further explore the dynamic relationships between anthropometric parameters, nutritional intake, and athletic performance in junior basketball players. Additionally, incorporating comprehensive assessments of other factors such as physical fitness, skill development, and psychosocial well-being would provide a more holistic understanding of youth athlete development. In conclusion, this study contributes to the growing body of literature on sports science and youth athlete development, emphasizing the importance of considering both anthropometric and nutritional factors in optimizing the performance and health of junior basketball players.

REFERENCES

1. Arie, L. and Liubov, B. N. Relationship between changes in neck circumference and changes in blood pressure, 2004, American Journal of Hypertension, 17 (5): 409-414. Citation from: https://doi.org/10.1016/j.amjhyper.2004.02.005; Retrieved on: 24th May, 2024.
2. Arnold, T. J. Schweitzer, A. Hoffman, H. J. Onyewu, C.Hurtado, M. E. Hoffman, E. P. and Klein, C. J. Neck and Waist Circumference Biomarkers of Cardiovascular Risk in a Cohort of Predominantly African-American College Students: a Preliminary Study. *Journal of Academy of Nutrition and Diet*, 2014, 114(1): 107-116; Citation from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC 5910608/#CR17; Retrieved on: 19th December, 2018.
3. Burke, L. M., Hawley, J. A., Wong, S. H. S., & Jeukendrup, A. E. Carbohydrates for training and competition. Journal of Sports Sciences, 2021, 39(1), 32-39. Citation from: https://doi.org/10.1080/02640414.2020.1784224; ; Retrieved on: 24th May, 2024.
4. Cabral, C. A. C. Rosado, G. P. Silva, C. H. and Marins, J. C. Diagnosis of the Nutritional Status of The Weight Lifting Permanent Olympic Team of The Brazilian Olympic Committee. *Rev Bras Med Esporte*, 2006, 12(6): 308-312; Citation from: https://pdfs.semanticscholar.org/0638/c6833040948893dd0102f00 d87c96f89b8a5.pdf; Retrieved on: 17th January, 2019.
5. CDC (Centers for Disease Control & Prevention)-National Health Statistics Reports- Vital & Health Statistics, 2008, 2009 & 2012.
6. Claudino, J. G., Gabbett, T. J., Bourgeois, F., de Sá Souza, H., Miranda, R. C., Mezêncio, B., & Amadio, A. C. CrossFit overview: Systematic review and meta-analysis. Sports Medicine - Open, 2019, 5(1), 11. https://doi.org/10.1186/s40798-018-0170-6
7. Daskalovski, B. Zafirovska, A. and Shukova-Stojmanovska, D. Value of BMI (Body Mass Index) in Basketball Players of BC VARDAR –SKOPJE. *Resaarch in Kinesiology*, 2013, 41(1):124-126; Citation from: http://fsprm.mk/wp-content/uploads/2013/08/Pages-from-Spisanie-RIK-br.1-2013-20.pdf; Retrieved on: 12th December, 2018.
8. Deshpande, P. & Nande, P. Anthropometric Measurements and Physical Fitness of Boys Engaged in Gymnastics. International Journal of Informative & Futuristic Research, 2016, 4(2): 5159-5165; Citation from: https:// www.academia.edu/29408149/ANTHROPOMETRIC_MEASUREMENTS_AND_PHYSICAL_FITNESS_OF_BOYS_ENGAGED_IN_GYMNASTICS_IJIFR-V4-E2-026_; Retrieved on: 10th December, 2018.
9. Fryar, C. D. Gu, Q. and Ogden, C. L. Anthropometric Reference Data for Children and Adults: United States, 2007–2010. National Center for Health Statistics.*Vital Health Statistics*, 2012, 11(252): 11; Citation from: https://www.cdc.gov/nchs/ data/series/sr_11/sr11_252.pdf; Retrieved on: 24th February, 2017.
10. Gopalan, C. Ramasastri, B. V. and Balsubramanian, S. C. Nutritive Value of Indian Foods. NIN Publication, ICMR, Hyderabad, 2012: 47-80.
11. Greene,J. J. McGuine, T. A. Leverson, G. and Best, T. M. Anthropometric and Performance Measures for High School Basketball Players. *Journal of Athletic Training*, 1998, 33(3): 229-232; Citation from: http://www.ncbi.nlm.nih.gov/ pmc/articles/PMC1320428/; Retrieved on: 12th February, 2016.
12. Heyward, V. H., & Wagner, D. R. Applied Body Composition Assessment, 2004, Human Kinetics.

13. Hrysomallis, C. Neck Muscular Strength, Training, Performance and Sport Injury Risk: a Review. *Sports Medicine*, 2016, 46(8): 1111-1124; Citation from: https://link.springer.com/article/10.1007%2Fs40279-016-0490-4#citeas; Retrieved on: 24th December, 2018.
14. http://www.layups.com/gaining-weight-as-a-basketball-player/
15. http://www.philly.com/philly/blogs/sportsdoc/Your-hips-and-your-athletic-performance. html
16. https://athlometrix.com/en/ chest-circumference/
17. https://en.wikipedia.org/wiki/Height_in_sports
18. https://www.abc.net.au/news/health/2017-09-06/waist-size-why-it-matters-and-when-its-a-risk/8839708
19. https://www.technogym.com/int/wellness/the-neck-the-power-behind-the-head/
20. Indian Council of Medical Research (ICMR). Growth and Physical Development of Indian Infants and Children. By-P. N. Wahi-Director General-ICMR, Medical Enclave, New Delhi, Technical Report Series No. 18, 1972: 40 & 41.
21. Indian Council of Medical Research (ICMR). Growth and Physical Development of Indian Infants and Children, New Delhi, Technical Report Series No.18, 1984:45.
22. Indoria, A. & Singh, N. Role of Nutrition in Sports: A Review. *Indian Journal of Nutrition*, 2016, 3 (2): 1-6. Citation from: http://www.opensciencepublications. com/wp-content/uploads/IJN-2395-2326-3-147.pdf; Retrieved on: 17th January, 2019.
23. Karki, B. B. Bhattarai, M. D. Bajracharya, M. R. Karki, S. & Devkota, A. R. Correlation of Neck and Wrist Circumference with Waist Circumference. *Journal of Advances in Internal Medicine*, 2015, 3:47; Citation from: https://www.research gate.net/publication/286638892_Correlation_of_neck_and_wrist_circumference_with_waist_circum ference; Retrieved on: 27th December, 2018.
24. Liubov, B. N. (Louba), Ezra, S. and Arie, L. Neck Circumference As A Simple Screening Measure For Identifying Overweight And Obese Patients. *Obesity Research*, 2001, 9(8): 470-477; Citation from: https://onlinelibrary.wiley.com /doi/full/10.1038/oby.2001.61; Retrieved on: 9th December, 2018.
25. Longvah, T. Ananathan, R. Bhaskarachary, K. & Venkaiah, K. Indian Food Composition Tables. National Institute of Nutrition (Indian Council of Medical Research), Department of Health Research, Ministry of Health & Family Welfare, Government of India, Hyderabad, Telangana State, India, 2017, 1-578.
26. Lou, D. H. Yin, F. Z. Wang, R. Ma, C. M. Liu, X. L. & Lu, Q. Neck Circumference is an Accurate and Simple Index for Evaluating Overweight and Obesity in Han Children, 2012, *Annals of Human Biology*, 39: 2, 161-165; Citation from: https://www.tandfonline.com/doi/abs/10.3109/03014460.2012.660990; Retrieved on: 25th December, 2018.
27. Malina, R. M. Hamill, P. V. and Lemeshow, S. Selected Body Measurements of Children 6-11 Years. *Vital and Health Statistics,* DHEW Publication No. (HSM) 73-1605, 1973, 11(123): 28; Citations from: https://www.cdc.gov/nchs/data/series /sr_11/sr11_123acc.pdf; Retrieved on: 7th March, 2017.
28. Mazicioglu, M. M. Kurtoglu, S. Ozturk, A. Hatipoglu, N. Cicek, B. and Ustunbas, H. B. Percentiles and Mean Values for Neck Circumference in Turkish Children Aged 6-18. *Acta Paediatrica*, 2010, 99(12): 1847-1853; Citation from: https:// www.ncbi.nlm.nih.gov/pubmed/20682008; Retrieved on: 5th December, 2018.
29. McArdle, W. D. Katch, F. I. and Katch, V. L. Exercise Physiology: Energy, Nutrition, and Human Performance. Exercise Physiology. 6th Edition, Lippincott Williams & Wilkins. 2007, 794-795; Citation from: https://trove.nla.gov.au/ work/6440733?q&sort=holdings+desc&_=1551770228216&versionId=46536399+249618620; Retrieved on: 15th December, 2018.
30. McDowell, M. A. Fryar, C. D. and Ogden, C. L. Anthropometric Reference Data for Children and Adults: United States, 1988-1994. National Center for Health Statistics. Vital Health Statistics, 2009, 11(249): 57; Citations from: https:// www.cdc.gov/nchs/data/series/sr_11/sr11_249.pdf; Retrieved on: 7th March, 2017.
31. Mohamed, A. N. I. Anthropometric Measurements as a Significant for Choosing Juniors in Both Volleyball and Handball Sports (Factorial Analysis Study). *World Journal of Sport Science*, 2012, 3(4): 277-289; Citation from: https://core.ac.uk/ download/pdf/82311265.pdf; Retrieved on: 25th December, 2018.
32. Nafiu, O. O. Burke, C. Lee, J. Voepel-Lewis, T. Malviya, S. and Tremper, K. K. Neck Circumference as a Screening Measure for Identifying Children with High Body Mass Index. *Pediatrics,* 2010, 126(2): 306-310; Citation from: http://pediatrics.aappublications.org/content/126/2/e306.short; Retrieved on: 25th December, 2018.
33. Nande, P. Mudafale, V. and Vali, S. Anthropometric Profile of Female and Male Players Engaged in Different Sports Disciplines. *The Internet Journal of Nutrition and Wellness*, 2008, 8(1); Citation from: http://ispub.com/IJNW/8/1/13014#; Retrieved on: 25th December, 2018.
34. National Health & Nutrition Examination Survey (NHANES). Anthropometry Procedures Manual. 2004, 1-65, Citation from: www.cdc.Gov/nchs/data /nhanes/ nhanes_03_04/BM.pdf; Retrieved on: 25thNovember, 2018.

35. National Institute of Nutrition (NIN)/Indian Council of Medical Research (ICMR). Nutrient Requirements & Recommended Dietary Allowances for Indians. A Report of the Expert Group of the Indian Council of Medical Research (ICMR), National Institute of Nutrition (NIN), Hyderabad, 2009.
36. National Nutrition Monitoring Bureau (NNMB): Diet & Nutritional Status of Rural Population. Technical Report No 21, National Institute of Nutrition (NIN), ICMR (Indian Council Medical Research), Hyderabad, 2002.
37. Ode, J. J. Pivarnik, J. M. Reeves, M. J. and Knous, J. L. Body Mass Index asa Predictor of Percent Fat in College Athletes and Nonathletes. *Medicine and Science in Sports and Exercise*, 2007, 39 (3): 403-409; Citation from: https://www.ncbi.nlm.nih.gov/pubmed/17473765; Retrieved on: 2ndApril, 2017.
38. Osterberg, K. L. Horswill, C. A. and Baker, L. B. Pregame Urine Specific Gravity and Fluid Intake by National Basketball Association Players during Competition. *Journal of Athletic Training*, 2017, 44(1): 53-57; Citation from: http://www. natajournals.org/doi/abs/10.4085/1062-6050-44.1.53; Retrieved on: 29th January, 2019.
39. Patil, S. S. Patil, S. R. Durgawale, P. M. Kakade, S. V. and Kumar, A. Study of Physical Growth Standards of Adolescents (10-15 Years) From Karad, Maharashtra. *International Journal of Collaborative Research on Internal Medicine & Public Health*, 2013, 5(1):10-18; Citation from: http://internal medicine.imedpub.com/study-of-physical-growth-standards-of-adolescents-1015 years-from-karad-maharashtra.pdf; Retrieved on: 10th December, 2018.
40. Penggalih, M. H. Juffrie, M. Sudargo, T and Sofro, Z. M. Correlation between Dietary Intakes with Anthropometry Profile on Youth Football Athlete in Indonesia. *Asian Journal of Clinical Nutrition*, 2017, 9: 9-16; Citation from: https://scialert.net/abstract/?doi=ajcn.2017.9.16;Retrieved on: 18th January, 2019.
41. Prajakta, N. Bhawnani, N. and Sabiha. V. Assessment of Nutritional Status and Physical Fitness of Female Swimmers.*Journal of Exercise Science and Physiotherapy*, 2010, 6(1): 7-21; Citation from: http://medind.nic.in/jau/t10/ i1/jaut10i1p7.pdf; Retrieved on: 16th January, 2019.
42. Rodriguez, N. R., DiMarco, N. M., Langley, S., & American Dietetic Association, Dietitians of Canada, and American College of Sports Medicine. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. Journal of the American Dietetic Association, 2009, 109(3), 509-527. https://doi.org/10.1016/j.jada.2009.01.005
43. Saka, M. Turker, P. Ercan, A. Kiziltan, G and Bas, M. Is Neck Circumference Measurement an Indicator for Abdominal Obesity? A Pilot Study on Turkish Adults. *African Health Sciences*, 2014, 14(3): 570-575; Citation from: https:// www.ncbi.nlm.nih.gov/pmc/articles/PMC4209643/; Retrieved on: 25th December, 2018.
44. Santos, D. A., Silva, A. M., Matias, C. N., Magalhães, J. P., Minderico, C. S., Thomas, D. M., ... & Sardinha, L. B. Utility of novel body indices in predicting fat mass in elite athletes. Nutrition Journal, 2014, 13(1), 41. https://doi.org/10.1186/1475-2891-13-41
45. Sharma, J. C. Physical Growth and Development of the Maharashtrians. Forwarded by-Chopra, S. R. K. Lucknow, Ethnographic And Folk Culture Society, U.P. 1970, 7-11.
46. Shivani & Tripathi, A. K. An Analytical Study of Chest Girth, Vital Capacity and Respiratory Rate of Inter Collegiate Players of Selected Ball Games.*Global Journal of Medical Research: K Interdisciplinary*, 2017, 17(1); Citation from: https://medicalresearchjournal.org/index.php/GJMR/article/download/1271/1181/; Retrieved on: 4th February, 2019.
47. Singh, K. and Ram, M. Kinanthropometric Profile as a Predictor of Basketball Players Strength Measures. *International Journal of Innovative Research & Development*, 2013, 2(8): 355-360; Citation from: http://www.ijird.com/index.php/ ijird/article/viewFile/36497/29473; Retrieved on: 11th December, 2018.
48. Snyder, R. G. Schneider, L. W. Owings, C. L. Reynolds, H. M. Golomb, H. and Schork, M. A. Anthropometry of Infants, Children, and Youths to Age 18. *For Product Safety DesignFinal Report. UM-HSRI-77-17*, 1977:287. Citation from: https://www.scribd.com/doc/45252116/Child-Anthropometry-Data; Retrieved on: 10th March, 2017.
49. Snyder, R. G. Spencer, M. L. Owings, C. L. and Schneider, L. W. Physical Characteristics of Children as Related to Death & Injury for Consumer Product Safety Design and Use. *UM-HSRI-BI-75-5 Final Report Contract FDA-72-70*, 1975; Citation from: http://ovrt.nist.gov/projects/anthrokids/images1975/\pcc0 48.gif; Retrieved on: 7th March, 2017.
50. Tomovic, M.Batinic, D.Saranovic, S. D. Anthropometric Features of Elite Male Basketball Players Regarding their Playing Position. Can a High BMI be a Health Risk for this Group of Athletes? *British Journal of Sports Medicine*, 2016, 50: A82; Citation from: https://bjsm.bmj.com/content/50/Suppl_1/A82.1; Retrieved on: 9th December, 2018.
51. World Health Organization. (2020). Body mass index – BMI. Retrieved from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
52. Yener, B. Ozer, B. K. Timur, G. Sagir, M and Galip, A. Anthropometric Characteristics of Female Basketball Players: Somatotype and Body Composition Values. *Directory of Open Access Journals*, 2007, 1(2): 52-62; Citation from:

https://www.researchgate.net/publication/41890848_ANTHROPOMETRIC_CHARACTERISTICS_OF_FEMALE_BASKETBALL_PLAYERS_SOMATOTYPE_AND_BODY_COMPOSITION_VALUES; Retrieved on: 15th February, 2016.