CHAPTER-IX

Discussion

(WITH 66 TABLES AND 37 FIGURES IN THE TEXT)

IX

DISCUSSION

9.1 ANTHROPOMETRIC OBSERVATION

Anthropometrics can be sensitive indicators of health, growth and development in children and adolescents (Falkner and Tanner 1986). Adolescence is a period of rapid growth and maturation in human development. In particular anthropometry has been used during adolescence in many contexts since adolescent anthropometry varies significantly worldwide (Eveleth and Tanner 1990, WHO 1995). There have been numerous anthropometric studies among growing boys and girls throughout the world (Hamill et al. 1979, Eveleth and Tanner 1990, Frisancho 1990) including India (ICMR 1989, ICMR 1996, Chatterjee and Mandal 1991, Bhadra et al. 2004). However, inadequate information is available on the anthropometric dimensions of Bengalee children and adolescents (Bhadra et al. 2004, Bose et al. 2005, Hauspie et al. 1980, Pakrasi et al. 1988, de Onis et al. 2001, Mukhopadhyay et al. 2005). However, these investigations did not study Bengalee Muslim adolescents anthropometric dimentions, body fat distribution and body composition in details.

The findings of the present research investigation constitute the most comprehensive and imperative anthropometric information of the Bengalee Muslim adolescents to date, which will be useful as a comparative database for other population studies in India. The age-wise distributions of different anthropometric profiles of the present samples are agrees, in general, with the earlier studies (ICMR 1996, Savva et al. 2001, Mukhopadhyay et al. 2007, Bamoshmoosh et al. 2013). Age variations in height, weight, circumferences and skinfolds were statistically significant ($p<0.01$). Moreover, all

the anthropometric measures show significant ($p<0.01$) positive alliance with age and the effect of age on these parameters are statistically significant ($p<0.01$). Mean differences of different anthropometric characteristics between present samples and other studies (Savva et al. 2001, ICMR 1996, Mukhopadhyay et al. 2007, Bamoshmoosh et al. 2013, R. K. et al. 2015) are statistically significant ($p<0.05$). Net and percent increases in anthropometric characteristics of adolescents (***Table 9.1***) from 10 to 17 years confirm an obvious growth pattern (***Fig. 9.1 and 9.2***). Height of boys increases 21.97% and weight increases 51.77% from 10 to 17 years of age. Height of girls increases 15.88% and weight increases 44.82% from 10 to 17 years of age. The maximum percent increase of boys in girth and skinfold measurement occurs in mid-upper arm circumference (25.49%) and subscapular skinfold (37.10%), respectively. The maximum percent increase of girls in girth and skinfold measurement occurs in maximum hip circumference (21.44%) and subscapular skinfold (43.96%), respectively.

A detailed comparative evaluation of respective anthropometric characteristics was done with best available published documents to assess age-specific status of the Bengalee Muslim adolescents on the basis of different parameters under study. However, a few variables especially different circumferential and skinfold measures and some derived metric variables of girls of the present findings could not evaluated because of non-availability of comparable published materials.

Comparative study of height of boys with different earlier findings (***Table 9.4***) reveals that the age-wise mean values of the Bengalee Muslim adolescents of boys are lower in each age group except the age group of 15 years to the national standards given by the ICMR (1996). However, present mean values are slightly lower in each age group than another study in Bengalee adolescents (Mukhopadhyay A. 2007) but present mean value are higher (***Fig. 9.7***) in each age group except the age groups of 13 and 14 years in Yemeni children (Bamoshmoosh et al. 2013). ANOVA reflected age-specific significant difference ($p<0.01$) in height of boys among these studies from 11 to 16 years. Whereas the differences are not significant at the level 0.05 in the age group of 10 and 17 years.

Comparative study of height of girls with different earlier findings (***Table 9.5***) reveals that the age-wise mean values of the Bengalee Muslim adolescents of girls are

higher in each age group to the national standards given by the ICMR (1996). However, present mean values are higher at each age group than another study in Yemeni girls adolescent (Bamoshmoosh et al. 2013). On the contrary, result of the Savva et al. (2001) was markedly greater at each age group than the three findings including the present study (***Fig. 9.8***). ANOVA reflected age-specific significant difference ($p<0.01$) in height of girls among these studies from 10 to 17 years.

Mean values of body weight of boys (***Table 9.6***) of the present finding are lower in each age group except in age groups of 15 and 16 years to the earlier studies among Bengalee Hindu school-going boys of Nimta under the North Dumdum Municipality (Kolkata) reported by Mukhopadhyay A. (2007) and Yemeni children reported by Bamoshmoosh et al. (2013). Age-wise means of body weight of boys demonstrate that the Bengalee Muslim adolescents are slightly heavier than the boys given by ICMR (1996) standard (***Fig 9.9***). The variances in weight of boys among these studies are statistically significant ($p<0.01$) in the age groups 10 to 15 years. Whereas the differences are not significant at the level 0.05 in the age group of 16 and 17 years.

Mean values of body weight of girls (***Table 9.7***) of the present finding are lower in each age group except in the age group of 13 years to the earlier study among Yemeni children reported by Bamoshmoosh et al. (2013). Age-wise means of body weight of girls demonstrate that the Bengalee Muslim adolescents are slightly heavier than the girls given by ICMR (1996) standard. On the contrary, result of the Savva et al. (2001) was markedly greater in each age group than the three findings including the present study (***Fig 9.10***). The variances in weight of girls among these studies were statistically significant ($p<0.01$) in each age group.

Mid-upper arm circumference of boys of the present study (***Table 9.8***) demonstrates that the age-wise mean values are almost similar in each age to the Bengalee Hindu boys of Nimta, Kolkata studied by Mukhopadhyay A. (2007) but mean values of present study are higher in each age except the age group of 13 years to the ICMR (1996) standard. However, the age-wise mean values in each age except the age group of 15 years of an urban slum of Kolkata reported by Dasgupta et al. (2010) are higher than the present study (***Fig 9.11***). Significant differences ($p<0.01$) are observed

among these studies in the age group from 10 to 15 years. Whereas the differences are not significant at the level 0.05 in the age group of 16 and 17 years.

Mid-upper arm circumference of girls of the present study (***Table 9.9***) demonstrates that the age-wise mean values of Bengalee Muslim adolescents are higher in each age group than ICMR (1996) standard but lower (***Fig 9.12***) in each age group to the Sonowal Kacharis of Dibrugarh District, Assam, Northeast-India reported by Jaswant et al. (2014). Significant differences are observed among these studies in the age group of 10 to 15 years. However, ANOVA could not be calculated in the age group of 16 and 17 years due to lack of data.

A relative interpretation of the chest circumference (***Table 9.10***) of the studies samples of boys with two other Indian findings (ICMR 1996, Mukhopadhyay A. 2007) express that the Bengalee Muslim adolescents have larger mean chest diameter in all age groups to ICMR standard but Bengalee Muslim adolescents have larger mean chest diameter in all ages except in the age group of 13 and 14 years to Bengalee adolescents reported by Mukhopadhyay et al. 2007 (***Fig 9.13***). However, age-wise analysis of variance reveals that the variations among these studies were statistically significant in the age group of 10 to 15 years but ANOVA could not be calculated in the age group of 16 and 17 years due to lack of data.

Comparative study of Chest Circumferences of girls ***(Table 9.11)*** reveals that the age-wise mean values of Bengalee Muslim adolescents of girls are higher in each age group to ICMR (1996) standard (***Fig 9.14***). The mean differences between present study and ICMR standard of girls of chest circumference in each age group are statistically significant at the level 0.05.

A comparative evaluation of minimum waist circumference of boys of present study (***Table 9.12***) reveals that the age wise mean values of Bengale Muslim boys are higher in each age group except in the age group of 13 and 17 years to Bengalee boys reported by Mukhopadhyay A. (2007). The age wise mean values of Bengalee Muslim adolescent boys are almost similar in each age group to Bamoshmoosh et al. (2013) but the mean values of present study are extremely lower in each age group than the Cypriot

and Kuwait children reported by Savva et al. (2001) and Jackson et al. (2010).The variations are statistically significant ($p<0.01$) in each age group (***Fig 9.15***).

A comparative evaluation of minimum waist circumference of girls (***Table 9.13***) reveals that the age wise mean values of Bengalee Muslim adolescent girls are lower in each age group than the Cypriot (Savva et al. 2001) and Kuwait (Jackson et al. 2010) girls but higher in each age group except in the age groups of 14, 15, 16, and 17 years than the Yemeni girls reported by Bamoshmoosh et al. 2013. The variations are statistically significant ($p<0.01$) in each age group (***Fig 9.16***).

Comparative study of maximum hip circumferences ***(Table 9.14)*** reveals that the age-wise mean values of Bengalee Muslim adolescents of boys are higher in the age group of 10, 15, 16, 17 years and lower in the age group of 11 to 14 years than Bengalee Hindu boys repoted by Mukhopadhyay A. 2007. The age-wise mean values of Bengalee Muslim adolescents of boys are higher in the age group of 15 to 17 years and lower in the age group of 10, 11, 13, and 14 years but similar in the age group of 12 years than the Yemeni boys reported by Bomoshmoosh et al. 2013 (***Fig 9.17***). The variations are statistically significant only in the age group of 10 and 13 years. Whereas the differences are not significant at the level 0.05 in the age group of 11 to12 and 14 to17 years.

Comparative study of maximum hip circumferences ***(Table 9.15)*** reveals that the age-wise mean values of Bengalee Muslim adolescents of girls are higher in each age group except the age group of 10, 16 and 17 years than Yemeni girls reported by Bomoshmoosh et al. 2013 (***Fig 9.18***). The mean differences are statistically significant between Bengalee Muslim girls and Yemeni girls in the age groups of 13 and 14 years, but not significant from the age group 10 to 12 years and 15 to 17 years.

A comparative analysis of the biceps skinfold of boys of the present study is computes with (***Table 9.16***) the Bengalee Hindu boys of West Bengal studied by Mukhopadhyay A. (2007). The age wise mean values of Bengalee Muslim adolescents of boys are higher in each age group except the age group of 16 and 17 years than Bengalee Hindu boys (***Fig. 9.19***). The mean differences are statistically significant

between Bengalee Muslim boys and Bengalee Hindu boys in the age groups of 10 to 14 years, but not significant in the age groups of 15 and 16 years.

Comparative interpretation of the triceps skinfold of the Bengalee Muslim boys is done with two Indian studies (***Table 9.17***). The mean values of the triceps skinfold of the present sample are higher in each age group except the age group of 16 and 17 years than Bengalee Hindu boys reported by Mukhopadhyay A. (2007) and also higher in each age group except the age group of 17 years than Sonowal Kacharis boys of Dibrugard, Assam reported by Singh et al. (2014). Significant differences are observed among these studies in each age group except the age group of 16 years (***Fig 8.20***).

Comparative study of triceps skinfold of girls of present study ***(Table 9.18)*** reveals that the age-wise mean values of Bengalee Muslim adolescents of girls are lower in each age group except the age group of 10 and 11 years than Sonowal Kacharis girls reported by Singh et al. 2014 but age-wise mean values of Bengalee Muslim adolescents of girls are higher in the age group from 12 to 16 years than Tirupati girls reported by Anuradha et al. 2015 (***Fig 9.21***). Analysis of variance reveals that the differences are statistically significant ($p<0.01$) in the age groups from 12 to 16 years. However, ANOVA could not be calculated in the age groups of 10, 11 and 17 years due to lack of data.

Two truncal subcutaneous fat measures viz. subscapular skinfold (***Table 9.19***) and suprailiac skinfold (***Table 9.21***) of the present study of boys is compares with Bengalee Hindu boys of West Bengal (Mukhopadhyay A. 2007). The mean subscapular skinfold values of the present study of boys is greater in the age groups from 10 to 12 years but lesser in the age groups from 13 to 17 years and the mean suprailiac skinfold values of present study of boys are lower in each age group except the age group of 15 years than the Bengalee Hindu boys (Mukhopadhyay A. 2007). The mean differences of subscapular skinfolds between present studies boys and Bengalee Hindu boys are statistically significant at the 0.05 level in the age groups of 13, 14, 16 and 17 years (***Fig 9.22***). The mean differences of suprailiac skinfolds between present studies boys and Bengalee Hindu boys are statistically significant at the 0.05 level in the age groups of 13, 16 and 17 years (***Fig 9.24***).

Comparative study of subscapular skinfolds of girls of present study ***(Table 9.20)*** is compares with Tirupati girls of Andhra Pradesh (Anuradha et al. 2015). The mean values of subscapular skinfold measurements of girls of the present studies are greater in the age groups from 12 to 16 years than the Tirupati girls. The mean differences of subscapular skinfolds between present studies girls and Tirupati girls are statistically significant at the 0.05 level in the age groups from 12 to 16 years. T-test could not be computed in the age groups of 10, 11 and 17 years due to lack of data (***Fig 9.23***).

At the end, it may be summarised that the present cross-sectional study incorporated wide ranging anthropometric parameters and reports valuable data on physical growth pattern of Bengalee Muslim adolescents. Anthropometric measures are highly age and sex sensitive (Bhadra et al. 2004), similar future endeavor should be initiated on both sexes covering the whole postnatal growing period, i.e. from birth to maturity. This kind of study is most essential, not only to understand the pattern and intensity of physical growth, but also to recognize the changing dynamics of body size, shape, proportion and composition. However, till date, such efforts are lacking from India.

Table 9.1: Net and Percent Increase / decrease in Anthropometric Characteristics from 10 to 17 Years

Variables	Net increase /decrease	Percent increase /decrease	Net increase / decrease	Percent increase / decrease
	Boys		Girls	
Height (cm)	35.93	21.97	24.11	15.88
Weight (kg)	25.40	51.77	19.41	44.82
Circumferences (cm)				
Mid upper arm	5.84	25.49	4.63	20.93
Chest	20.91	25.31	16.16	20.46
Minimum waist	11.13	16.67	8.69	13.26
Maximum hip	19.68	23.82	17.38	21.44
Calf	6.68	21.68	5.67	19.20
Skinfolds (mm)				
Biceps	-0.20	-4.33	3.41	36.12
Triceps	-1.94	-28.12	2.90	21.00
Subscapular	3.45	37.10	6.30	43.96
Suprailiac	2.93	34.31	5.32	39.20
Medial calf	0.13	1.39	3.96	27.05

Table 9.4: Comparison of Age-wise Height (cm) of boys of Present Study With Other Studies

Age groups (years)	Present Study	ICMR,1996	Bamoshmoosh et al. 2013	Mukhopadhyay A. 2007	F- ratio
10.0-10.9	127.6 (4.70)	128.4 (6.70)	126.90 (10.00)	128.64 (7.36)	2.26 ns
11.0-11.9	131.6 (6.00)	132.6 (7.20)	129.30 (7.90)	132.01 (8.16)	7.39*
12.0-12.9	135.8 (5.76)	137.1 (7.90)	133.60 (8.40)	138.00 (8.70)	10.90*
13.0-13.9	136.1 (6.30)	142.1 (8.70)	141.50 (9.90)	145.62 (8.00)	18.47*
14.0-14.9	145.8 (9.91)	147.6 (9.40)	148.10 (9.70)	153.30 (8.86)	8.14*
15.0-15.9	158.1 (11.05)	152.6 (9.90)	150.30 (12.80)	157.63 (7.35)	13.13*
16.0-16.9	164.7 (5.97)	--	155.20 (9.60)	159.11 (8.06)	24.25*
17.0-17.9	163.5 (5.10)	--	160.10 (10.60)	157.51 (7.28)	3.98 ns

Standard deviations are presented in parentheses
ns – Not significant at the 0.05 level
* - significant at the 0.01 level

Table 9.5: Comparison of Age-wise Height (cm) of girls of Present Study with Other Studies

Age groups (years)	Present Study	ICMR,1996	Bamoshmoosh et al. 2013	Savva et al. 2001	F- ratio
10.0-10.9	127.71 (4.59)	127.40 (6.90)	122.7 (10.30)	142.46 (7.80)	201.23*
11.0-11.9	133.28 (5.34)	132.10 (7.60)	130.9 (9.90)	150.20 (7.40)	196.76*
12.0-12.9	140.95 (6.04)	137.10 (8.20)	133.6 (10.00)	155.10 (6.20)	199.91*
13.0-13.9	146.80 (7.45)	142.00 (8.20)	138.2 (9.90)	158.00 (6.90)	144.61*
14.0-14.9	149.45 (5.82)	146.10 (8.00)	143.9 (8.70)	159.70 (6.30)	114.86*
15.0-15.9	150.56 (5.46)	149.40 (7.80)	147.9 (10.10)	160.90 (6.60)	70.02*
16.0-16.9	152.73 (4.76)	--	149.9 (8.10)	160.80 (5.50)	75.85*
17.0-17.9	151.82 (5.98)	--	151.4 (9.60)	161.80 (5.70)	53.84*

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.6: Comparison of Age-wise Weight (kg) of boys of Present Study With Other Studies

Age groups (years)	Present Study	ICMR,1996	Mukhopadhyay A. 2007	Bamoshmoosh et al. 2013	F- ratio
10.0-10.9	23.66 (2.46)	23.30 (3.30)	25.01 (3.98)	26.80 (6.60)	45.23*
11.0-11.9	26.01 (4.26)	25.20 (3.70)	27.51 (5.13)	26.70 (4.80)	12.40*
12.0-12.9	28.98 (7.99)	27.60 (4.60)	30.89 (5.87)	29.90 (7.10)	25.67*
13.0-13.9	28.28 (5.11)	30.60 (5.40)	34.90 (7.04)	34.70 (8.20)	47.18*
14.0-14.9	34.95 (7.87)	34.40 (6.50)	38.75 (7.52)	39.20 (8.50)	32.60*
15.0-15.9	46.09 (10.77)	37.90 (7.00)	44.15 (8.03)	43.20 (11.70)	45.98*
16.0-16.9	50.09 (7.00)	--	47.79 (7.99)	47.30 (8.90)	2.28 ns
17.0-17.9	49.06 (5.47)	--	49.21 (11.03)	50.10 (9.30)	0.28 ns

Standard deviations are presented in parentheses
ns – Not significant at the 0.05 level
* - significant at the 0.01 level

Table 9.7: Comparison of Age-wise Weight (kg) of girls of Present Study With Other Studies

Age groups (years)	Present Study	ICMR,1996	Savva et al. 2001	Bamoshmoosh et al. 2013	F- ratio
10.0-10.9	23.90 (2.89)	22.90 (3.50)	39.20 (10.60)	25.80 (6.40)	553.59*
11.0-11.9	26.34 (4.89)	25.30 (4.30)	44.30 (10.10)	29.20 (7.50)	585.90*
12.0-12.9	30.54 (6.19)	28.40 (5.20)	48.20 (11.10)	32.50 (7.30)	506.61*
13.0-13.9	37.09 (6.84)	32.10 (5.90)	49.80 (8.70)	35.60 (6.70)	305.13*
14.0-14.9	39.59 (6.24)	35.70 (6.30)	52.90 (8.50)	41.10 (7.30)	282.17*
15.0-15.9	43.27 (7.88)	38.70 (6.10)	55.60 (9.00)	44.60 (10.30)	196.30*
16.0-16.9	42.65 (5.85)	--	54.90 (8.40)	47.60 (9.40)	42.45*
17.0-17.9	43.31 (6.21)		56.30 (9.60)	46.10 (8.70)	49.48*

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.8: Comparison of Age-wise Mid- upper arm circumferences (cm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	ICMR,1996	Mukhopadhyay A. 2007	Dasgupta et al. 2010	F- ratio
10.0-10.9	17.07 (1.17)	16.30 (1.30)	17.09 (1.98)	19.50 (1.77)	21.95*
11.0-11.9	17.54 (1.80)	16.90 (1.40)	17.62 (1.67)	18.11 (1.96)	10.29*
12.0-12.9	18.36 (2.83)	17.60 (1.60)	18.35 (1.94)	18.50 (2.18)	12.30*
13.0-13.9	18.05 (2.00)	18.50 (1.80)	19.39 (2.47)	21.11 (3.41)	36.93*
14.0-14.9	19.49 (2.23)	19.50 (2.10)	19.63 (2.04)	21.64 (3.19)	13.73*
15.0-15.9	21.89 (2.92)	20.70 (2.30)	21.30 (2.69)	21.29 (3.14)	6.78*
16.0-16.9	22.80 (2.18)	--	22.84 (3.10)	23.37 (2.61)	0.58 ns
17.0-17.9	22.91 (1.81)	--	23.10 (2.90)	24.28 (2.23)	2.24 ns

Standard deviations are presented in parentheses
ns – Not significant at the 0.05 level
* - significant at the 0.01 level

Table 9.9: Comparison of Age-wise Mid- upper arm circumferences (cm) of girls of Present Study with Other Studies

Age groups (years)	Present Study	ICMR,1996	Jaswant et al. 2014	F- ratio
10.0-10.9	17.49 (1.36)	16.60 (1.40)	17.67 (1.07)	26.94*
11.0-11.9	17.98 (2.10)	17.30 (1.60)	19.18 (1.79)	40.61*
12.0-12.9	18.82 (2.23)	18.00 (1.70)	20.72 (1.96)	75.32*
13.0-13.9	20.57 (2.20)	19.00 (1.90)	21.91 (2.30)	84.98*
14.0-14.9	21.49 (2.46)	20.00 (2.20)	22.34 (1.72)	43.98*
15.0-15.9	22.17 (2.69)	20.90 (2.20)	22.89 (1.72)	28.32*
16.0-16.9	21.51 (2.34)	-	23.74 (1.72)	-
17.0-17.9	22.12 (2.07)	-	23.94 (1.58)	-

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.10: Comparison of Age-wise Chest Circumferences (cm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	ICMR,1996	Mukhopadhyay A. 2007	F- ratio
10.0-10.9	61.72 (3.72)	58.20 (3.20)	60.47 (3.68)	49.09*
11.0-11.9	64.24 (5.24)	60.00 (3.40)	63.34 (4.30)	70.26*
12.0-12.9	66.04 (7.90)	62.00 (3.90)	65.46 (4.55)	63.35*
13.0-13.9	65.43 (5.26)	64.40 (4.30)	68.95 (6.29)	61.98*
14.0-14.9	70.40 (7.00)	67.00 (4.90)	71.15 (6.13)	37.28*
15.0-15.9	78.89 (8.46)	69.40 (5.20)	75.32 (7.18)	122.77*
16.0-16.9	82.52 (5.48)	-	76.26 (6.76)	-
17.0-17.9	82.63 (4.95)	-	78.74 (8.05)	-

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.11: Comparison of Age-wise Chest Circumferences (cm) of girls of Present Study with Other Studies

Age groups (years)	Present Study	ICMR,1996	T- test
10.0-10.9	62.81 (3.90)	57.40 (3.30)	12.06*
11.0-11.9	65.17 (6.22)	59.30 (3.80)	12.85*
12.0-12.9	68.11 (5.89)	61.60 (4.50)	12.87*
13.0-13.9	73.18 (5.98)	64.30 (5.20)	14.96*
14.0-14.9	75.39 (4.80)	66.90 (5.80)	12.79*
15.0-15.9	78.86 (6.01)	68.50 (6.30)	13.32*
16.0-16.9	77.95 (5.61)	-	-
17.0-17.9	78.97 (4.27)	-	-

Standard deviations are presented in parentheses
* - significant at the 0.05 level

Table 9.12: Comparison of Age-wise Minimum Waist Circumferences (cm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Savva et al. 2001	Mukhopadhyay A. 2007	Jackson et al. 2010	Bamoshmoosh et al. 2013	F-ratio
10.0-10.9	55.63 (2.78)	66.50 (10.10)	52.73 (3.25)	67.50 (12.80)	56.30 (7.50)	55.95*
11.0-11.9	57.26 (6.23)	66.90 (9.00)	54.32 (4.01)	72.10 (12.80)	57.00 (7.00)	68.82*
12.0-12.9	58.86 (8.66)	69.10 (8.90)	55.80 (4.06)	74.50 (13.60)	57.10 (8.40)	99.53*
13.0-13.9	58.09 (5.21)	71.40 (10.60)	58.93 (5.55)	75.70 (13.90)	61.40 (8.20)	87.37*
14.0-14.9	62.01 (6.04)	75.90 (11.00)	61.25 (5.69)	78.90 (15.20)	62.60 (8.10)	84.12*
15.0-15.9	67.29 (8.74)	75.20 (9.80)	62.74 (7.22)	82.20 (16.10)	66.80 (9.50)	53.74*
16.0-16.9	68.54 (5.81)	78.70 (9.80)	64.39 (6.38)	82.30 (16.10)	67.90 (9.20)	46.91*
17.0-17.9	66.76 (4.79)	79.30 (9.00)	67.28 (9.59)	83.60 (15.90)	68.10 (9.40)	45.10*

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.13: Comparison of Age-wise Minimum Waist Circumferences (cm) of girls of Present Study with Other Studies

Age groups (years)	Present Study	Savva et al. 2001	Jackson et al. 2010	Bamoshmoosh et al. 2013	F- ratio
10.0-10.9	56.87 (3.95)	65.40 (9.60)	66.80 (10.70)	54.90 (8.30)	61.83*
11.0-11.9	57.65 (5.77)	66.10 (7.20)	69.90 (11.50)	56.60 (8.70)	66.20*
12.0-12.9	59.16 (6.16)	67.00 (8.40)	71.70 (10.90)	59.00 (9.90)	65.34*
13.0-13.9	62.27 (6.00)	66.40 (6.00)	72.50 (10.90)	59.30 (10.00)	66.31*
14.0-14.9	62.89 (5.92)	68.10 (6.10)	75.30 (11.70)	63.70 (9.30)	63.61*
15.0-15.9	65.27 (7.64)	69.50 (6.50)	73.70 (12.00)	67.80 (8.80)	18.37*
16.0-16.9	63.83 (6.64)	68.50 (6.50)	73.60 (11.60)	68.00 (9.50)	20.72*
17.0-17.9	65.56 (6.84)	69.70 (7.30)	73.00 (12.60)	68.10 (9.60)	9.99*

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.14: Comparison of Age-wise Maximum Hip Circumferences (cm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	Bamoshmoosh et al. 2013	F- ratio
10.0-10.9	62.93 (3.48)	60.53 (4.99)	64.60 (9.10)	7.65*
11.0-11.9	64.17 (4.93)	64.44 (5.21)	65.20 (7.50)	0.58 ns
12.0-12.9	67.30 (7.29)	67.48 (5.10)	67.30 (9.00)	0.02 ns
13.0-13.9	66.42 (4.58)	70.92 (6.24)	71.70 (9.10)	13.91*
14.0-14.9	71.97 (6.47)	73.53 (6.18)	73.30 (8.50)	1.04 ns
15.0-15.9	80.35 (7.54)	77.96 (6.29)	77.20 (10.20)	2.94 ns
16.0-16.9	83.08 (4.86)	78.78 (6.81)	79.90 (9.30)	5.10 ns
17.0-17.9	82.61 (3.90)	80.58 (7.25)	80.30 (9.70)	1.29 ns

Standard deviations are presented in parentheses
ns - Not significant at the 0.05 level
* - significant at the 0.01 level

Table 9.15: Comparison of Age-wise Maximum Hip Circumferences (cm) of girls of Present Study with Other Studies

Age groups (years)	Present Study	Bamoshmoosh et al. 2013	T- test
10.0-10.9	63.68 (4.04)	64.10 (10.10)	0.32 ns
11.0-11.9	66.05 (6.05)	62.20 (10.40)	0.11 ns
12.0-12.9	70.03 (6.55)	69.70 (11.40)	0.24 ns
13.0-13.9	75.93 (6.96)	70.30 (11.60)	3.91*
14.0-14.9	78.26 (5.97)	75.20 (11.10)	2.25*
15.0-15.9	80.51 (6.21)	80.80 (10.30)	0.21 ns
16.0-16.9	80.34 (6.28)	82.40 (10.20)	1.37 ns
17.0-17.9	81.06 (6.09)	82.30 (9.90)	0.79 ns

Standard deviations are presented in parentheses
ns – not significant at the 0.05 level
* - significant at the 0.05 level

Table 9.16: Comparison of Age-wise Biceps Skinfold (mm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T- test
10.0-10.9	4.82 (1.19)	3.98 (0.95)	4.48*
11.0-11.9	5.62 (2.79)	4.49 (1.49)	2.65*
12.0-12.9	6.27 (3.36)	4.67 (1.19)	4.11*
13.0-13.9	5.72 (2.27)	4.77 (1.56)	3.45*
14.0-14.9	5.75 (2.29)	4.64 (1.69)	3.15*
15.0-15.9	6.12 (3.47)	5.04 (2.73)	1.92 ns
16.0-16.9	4.90 (1.83)	5.62 (2.55)	1.76 ns
17.0-17.9	4.62 (1.14)	7.12 (4.70)	3.45*

Standard deviations are presented in parentheses
ns – not significant at the 0.05 level
* - significant at the 0.05 level

Table 9.17: Comparison of Age-wise Triceps Skinfold (mm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	Singh et al. 2014	F- ratio
10.0-10.9	8.84 (2.12)	5.72 (1.54)	6.59 (2.30)	41.47*
11.0-11.9	9.33 (3.03)	6.60 (2.30)	7.05 (2.35)	18.47*
12.0-12.9	9.56 (3.66)	6.64 (1.61)	7.57 (2.98)	21.07*
13.0-13.9	9.44 (2.94)	7.18 (2.66)	7.43 (2.10)	18.11*
14.0-14.9	8.99 (2.82)	7.26 (2.36)	7.47 (2.09)	10.13*
15.0-15.9	9.11 (4.40)	7.52 (3.58)	8.11 (2.70)	2.99**
16.0-16.9	7.72 (3.35)	8.39 (3.03)	8.14 (2.85)	0.70 ns
17.0-17.9	6.90 (1.67)	10.33 (5.81)	6.72 (1.24)	14.79*

Standard deviations are presented in parentheses
ns – not significant at the 0.05 level
* - significant at the 0.01 level
** - significant at the 0.05 level

Table 9.18: Comparison of Age-wise Triceps Skinfold (mm) of girls of Present Study with Other Studies

Age groups (years)	Present Study	Singh et al. 2014	Anuradha et al. 2015	F- ratio
10.0-10.9	10.91 (2.81)	8.90 (2.18)	--	--
11.0-11.9	11.15 (3.47)	10.03 (3.84)	--	--
12.0-12.9	11.42 (3.87)	13.21 (4.32)	5.68 (2.53)	204.60*
13.0-13.9	12.97 (3.15)	15.68 (6.02)	5.63 (2.64)	339.86*
14.0-14.9	13.47 (3.79)	16.89 (4.65)	6.41 (2.73)	328.68*
15.0-15.9	14.61 (4.36)	17.25 (4.28)	6.47 (3.50)	139.91*
16.0-16.9	14.11 (3.80)	16.50 (4.60)	7.42 (3.38)	123.16*
17.0-17.9	13.81 (3.83)	15.52 (3.30)	--	--

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.19: Comparison of Age-wise Subscapular Skinfold (mm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T-test
10.0-10.9	5.85 (1.50)	5.73 (1.28)	0.49 ns
11.0-11.9	7.00 (3.79)	6.39 (2.16)	1.04 ns
12.0-12.9	7.17 (3.98)	7.13 (2.16)	0.08 ns
13.0-13.9	6.71 (2.95)	8.68 (4.19)	3.58*
14.0-14.9	7.25 (2.50)	9.34 (3.65)	4.05*
15.0-15.9	9.90 (4.77)	10.13 (7.21)	0.22 ns
16.0-16.9	9.32 (3.23)	11.79 (4.87)	3.38*
17.0-17.9	9.30 (2.17)	15.68 (12.74)	3.33*

Standard deviations are presented in parentheses
ns – not significant at the 0.05 level
* - significant at the 0.05 level

Table 9.20: Comparison of Age-wise Subscapular Skinfold (mm) of girls of Present Study with Other Studies

Age groups (years)	Present Study	Anuradha et al. 2015	T-test
10.0-10.9	8.03 (2.40)	--	--
11.0-11.9	8.88 (4.20)	--	--
12.0-12.9	9.05 (4.33)	5.70 (5.00)	5.50*
13.0-13.9	11.78 (4.30)	5.85 (2.69)	15.76*
14.0-14.9	12.59 (4.53)	6.76 (3.05)	13.56*
15.0-15.9	15.36 (5.77)	7.05 (3.04)	11.54*
16.0-16.9	13.33 (4.33)	7.69 (3.22)	9.44*
17.0-17.9	14.33 (4.59)	--	--

Standard deviations are presented in parentheses
* - significant at the 0.05 level

Table 9.21: Comparison of Age-wise Suprailiac Skinfold (mm) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T- test
10.0-10.9	5.61 (1.48)	5.71 (2.14)	0.30 ns
11.0-11.9	7.28 (4.29)	7.76 (4.95)	0.56 ns
12.0-12.9	7.95 (5.09)	8.62 (2.87)	1.03 ns
13.0-13.9	7.03 (3.29)	9.14 (4.87)	3.33*
14.0-14.9	8.35 (4.11)	9.46 (4.28)	1.56 ns
15.0-15.9	10.42 (5.52)	10.18 (7.03)	0.22 ns
16.0-16.9	9.20 (3.91)	11.57 (5.42)	2.72*
17.0-17.9	8.54 (2.87)	15.19 (10.66)	4.00*

Standard deviations are presented in parentheses
ns – not significant at the 0.05 level
* - significant at the 0.05 level

Fig 9.1: Percent Increase / decrease in Anthropometric Characteristics from 10 to 17 Years of boys

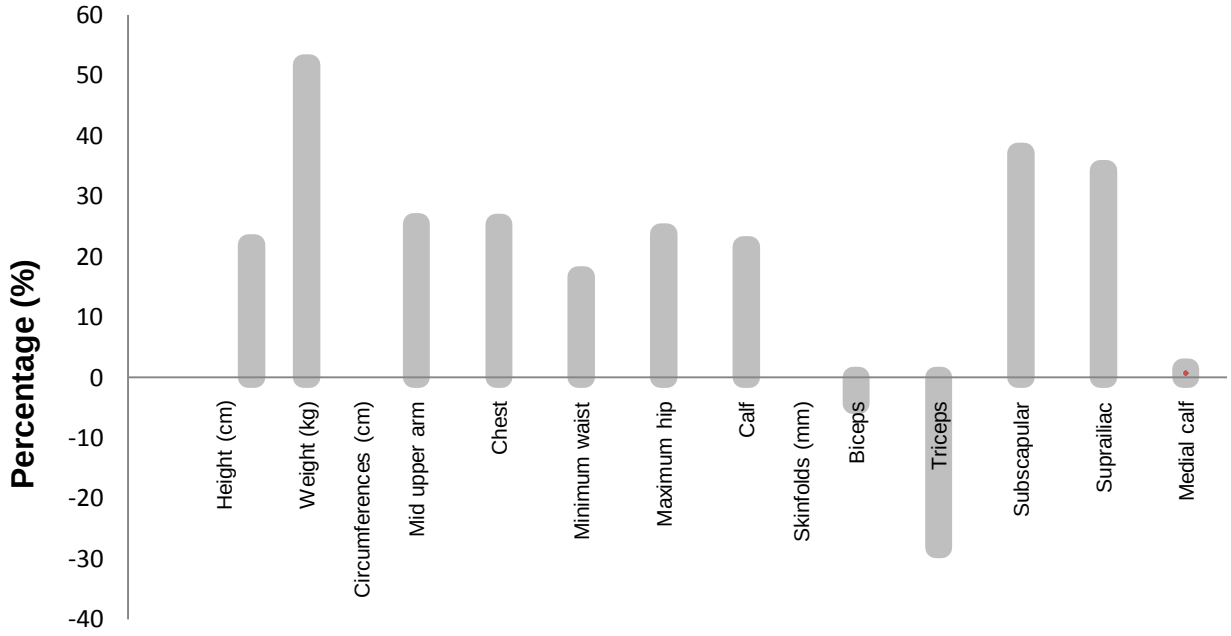


Fig 9.2: Percent Increase / decrease in Anthropometric Characteristics from 10 to 17 Years of girls

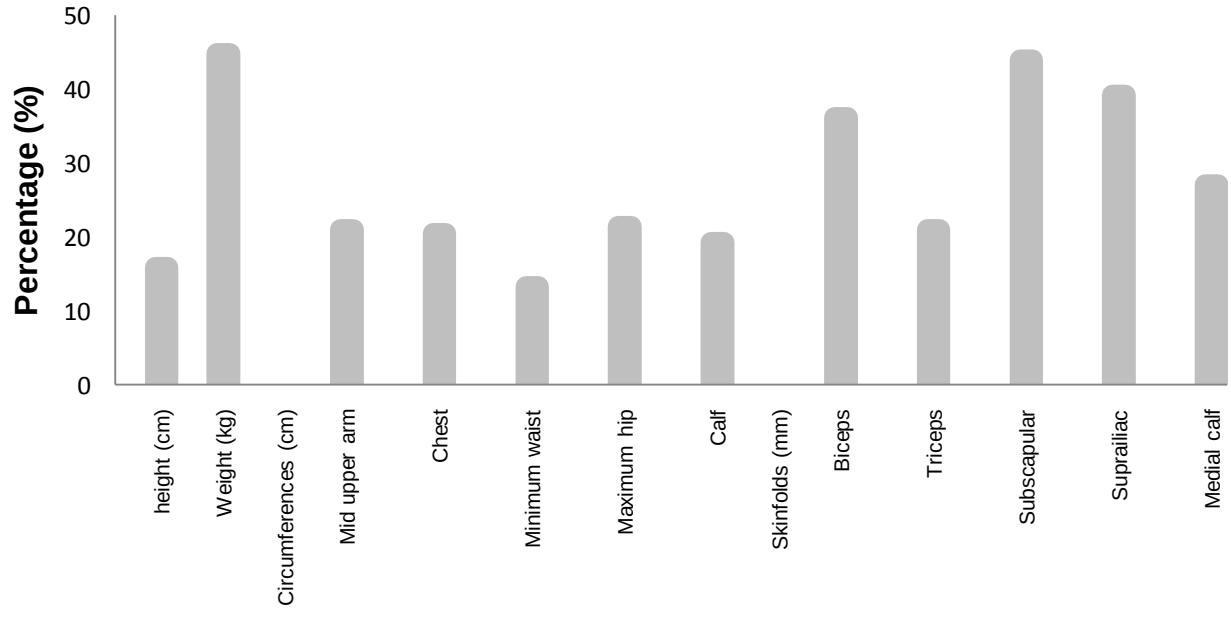


Fig 9.7: Comparative study of height (cm) of boys

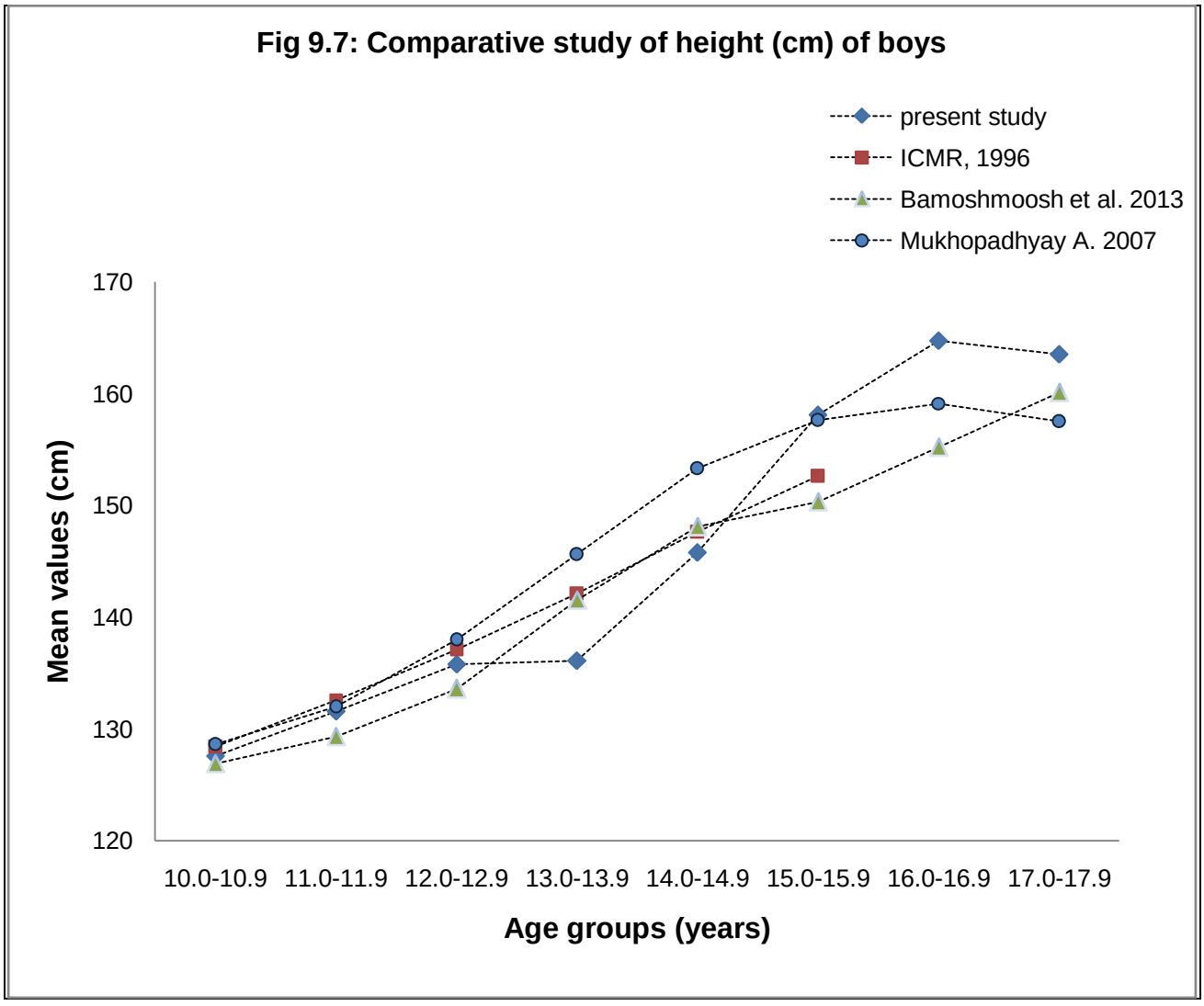


Fig 9.8: Comparative study of height (cm) of girls

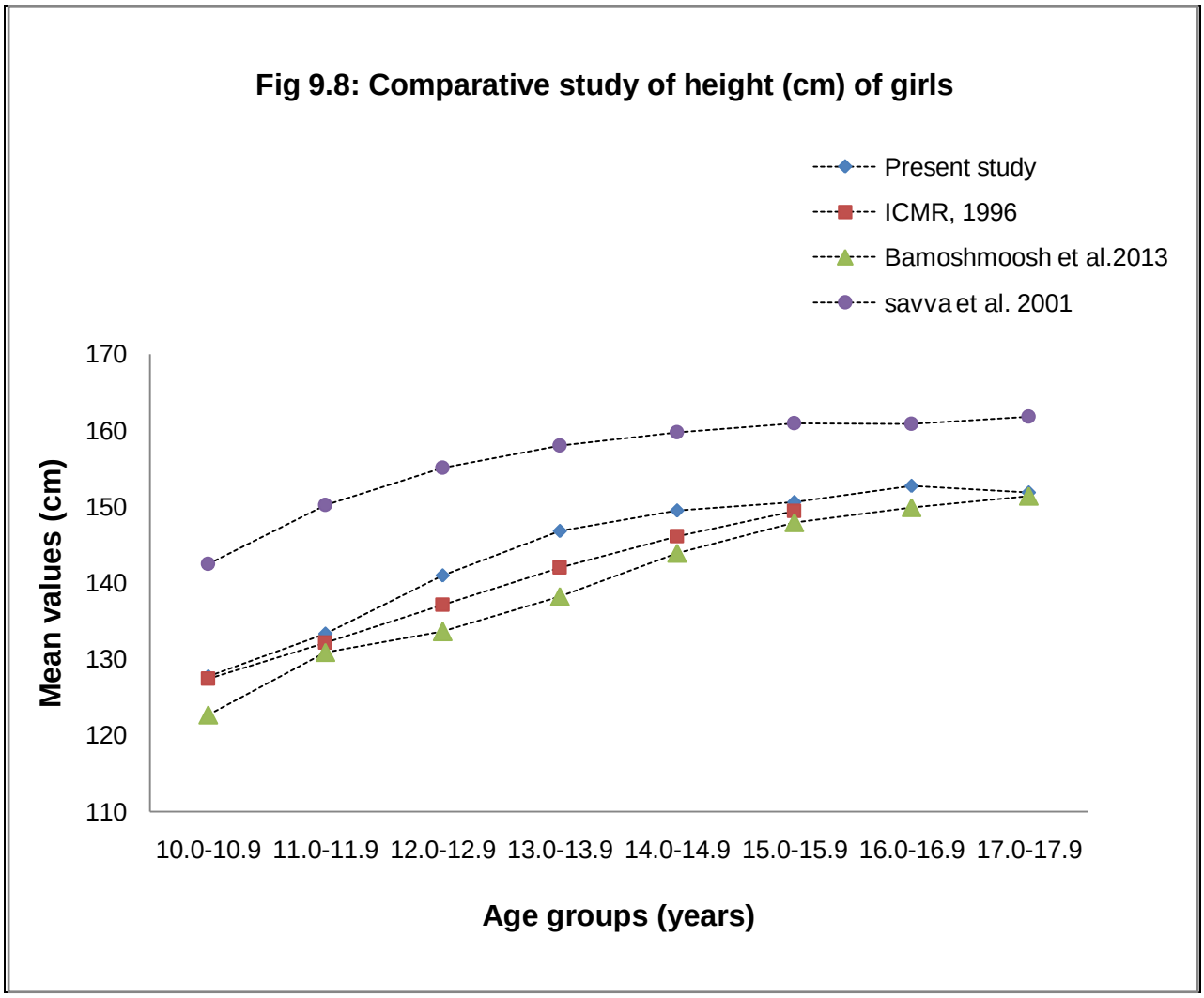


Fig 9.9: Comparative study of weight (kg) of boys

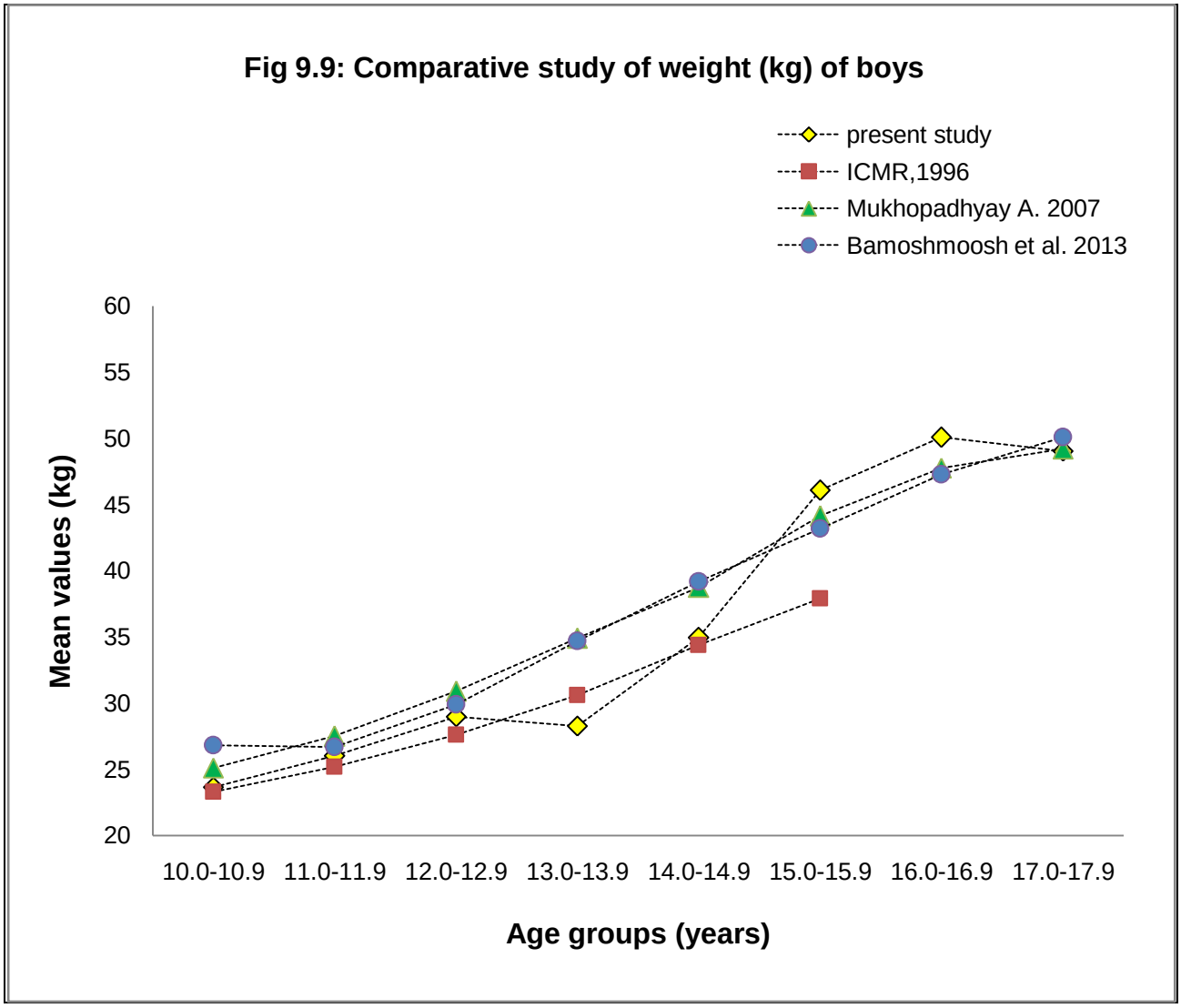


Fig 9.10: Comparative study of weight (kg) of girls

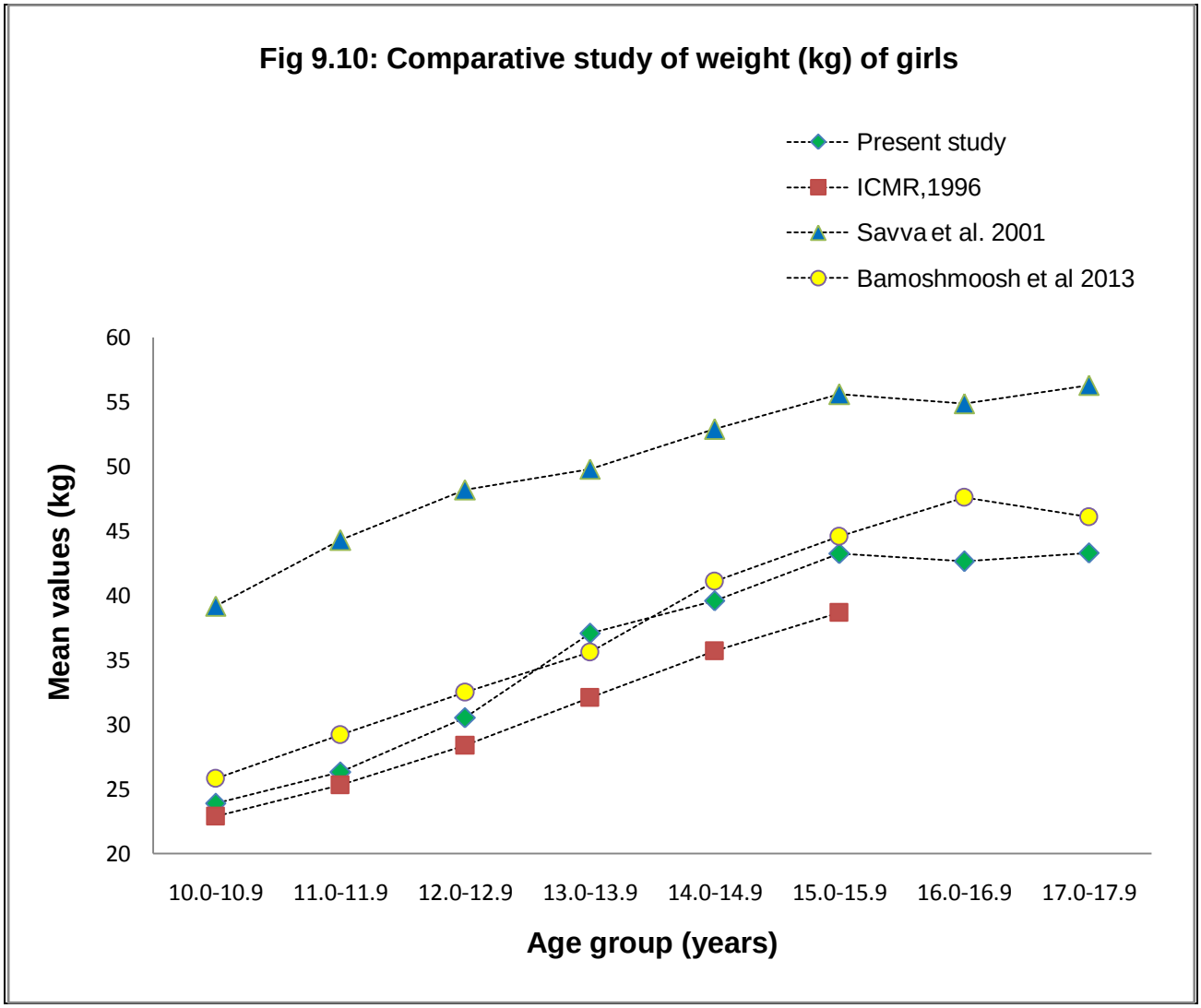


Fig 9.11: Comparative study of MUAC (cm) of boys

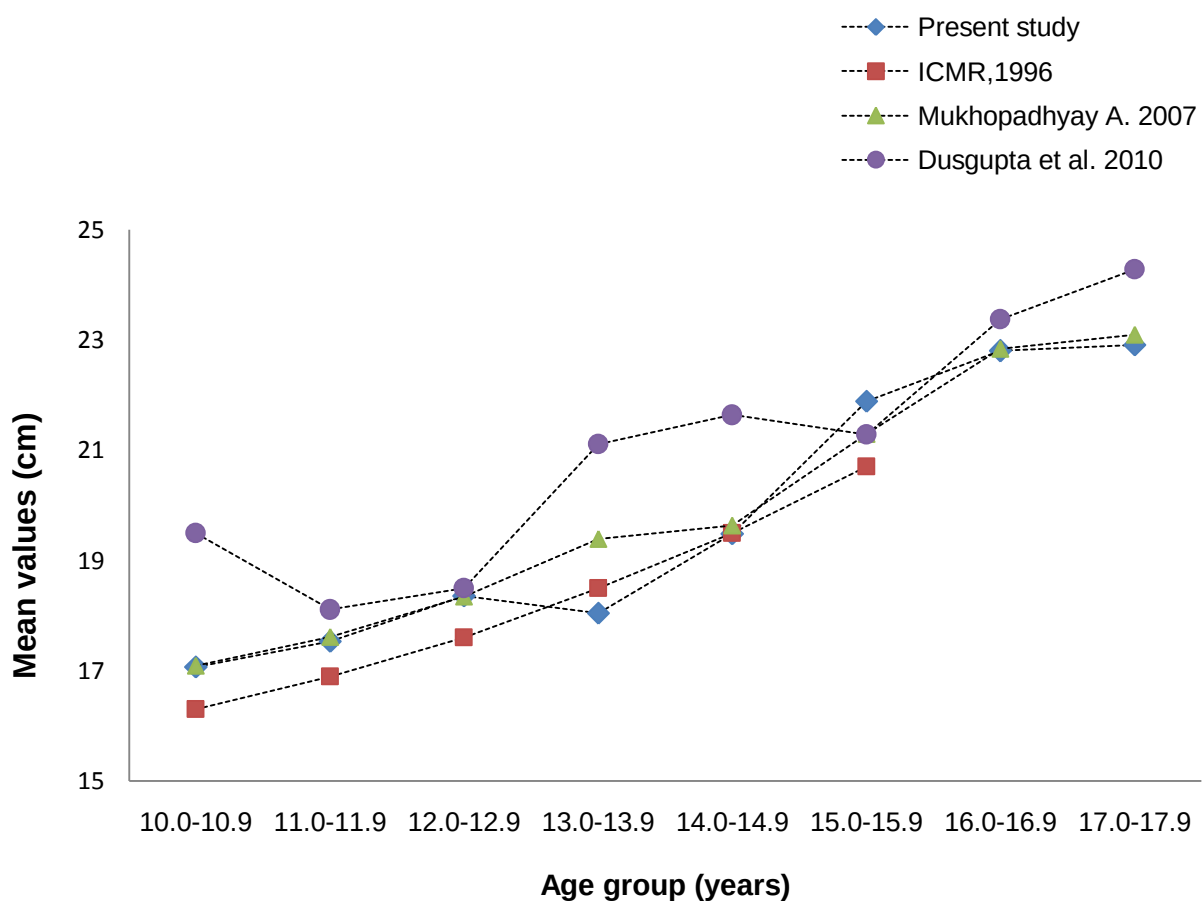


Fig 9.12: Comparative study of MUAC (cm) of girls

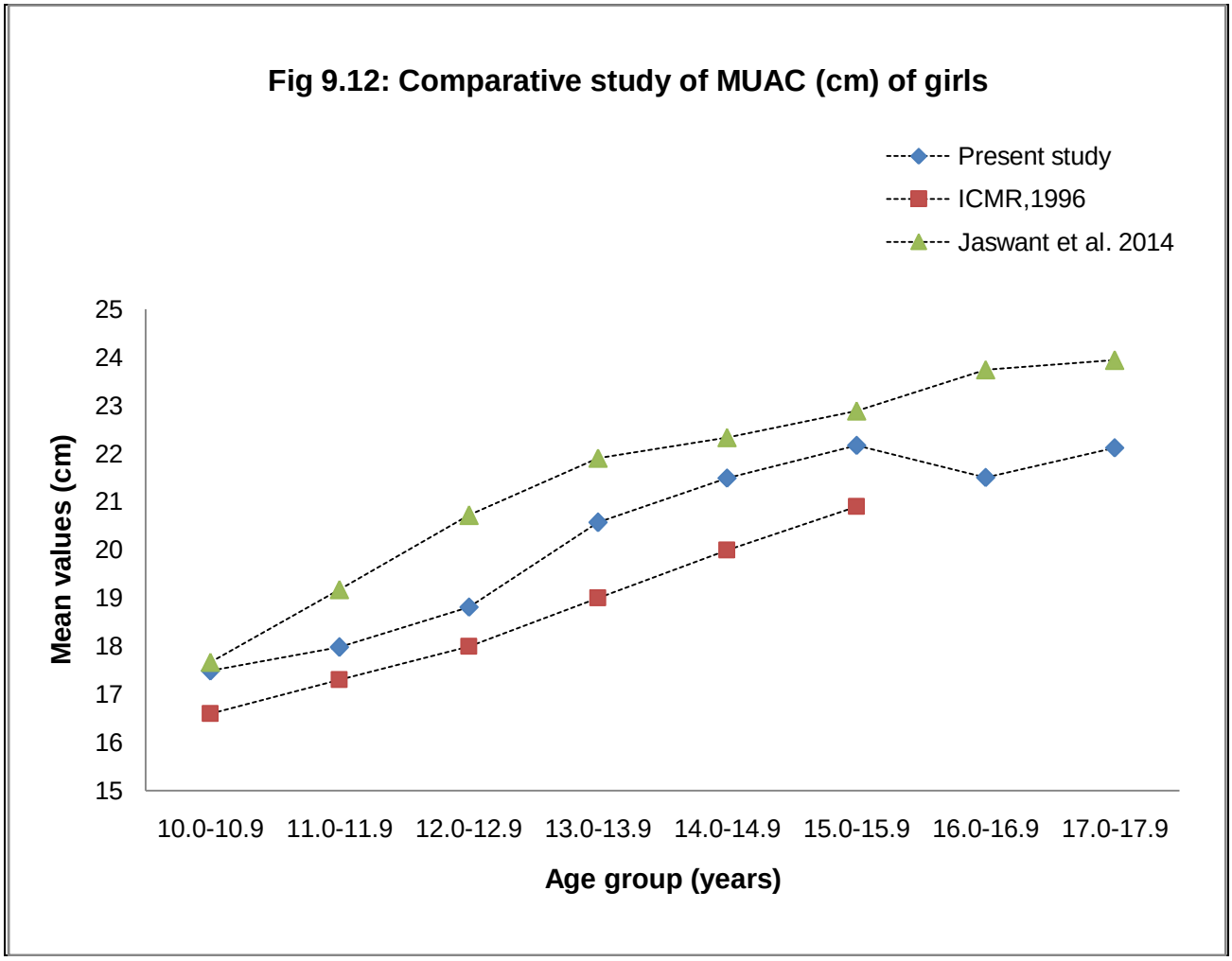


Fig 9.13: Comparative study of chest circumference of boys

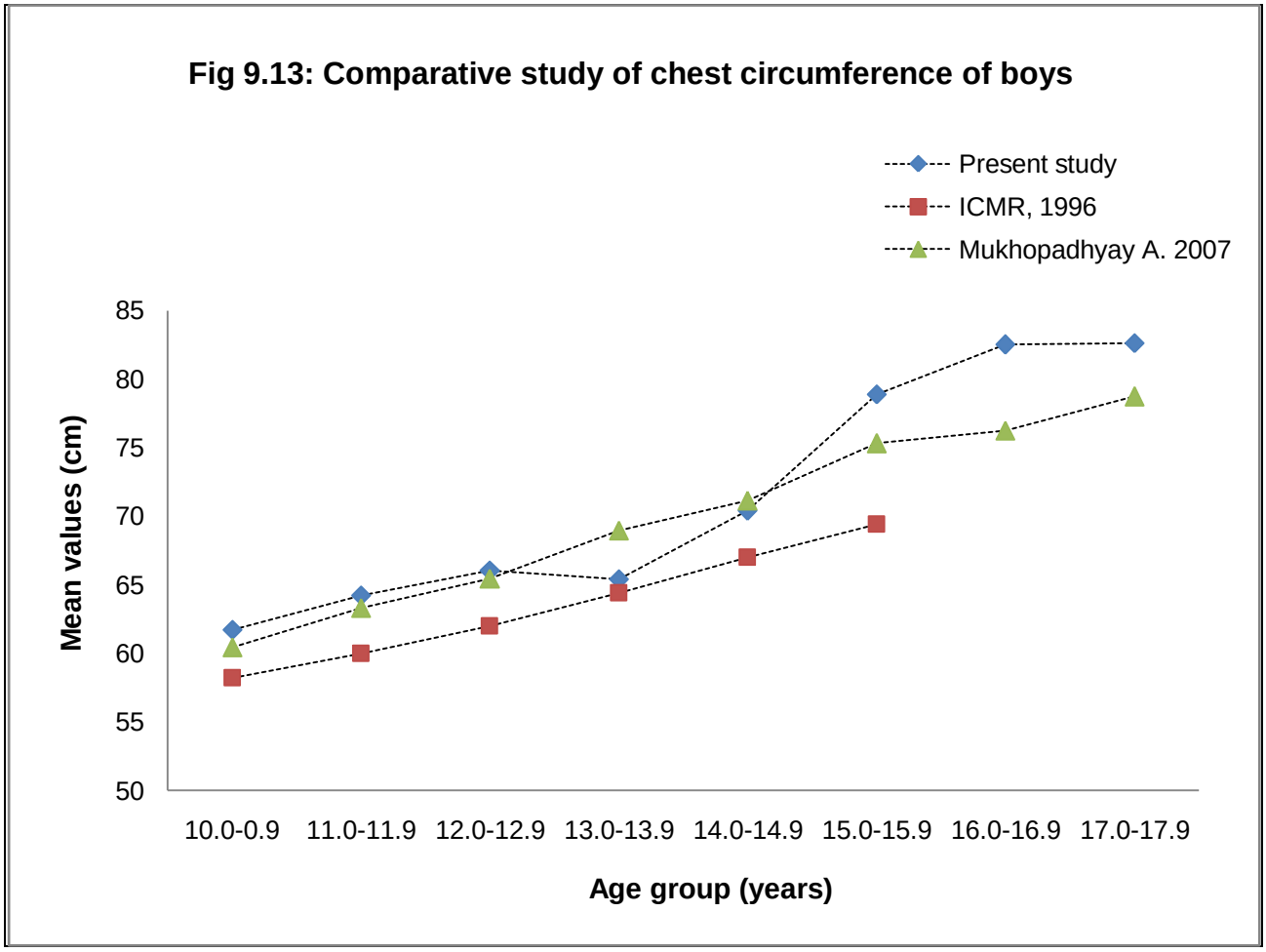


Fig 9.14: Comparative study of chest circumference of girls

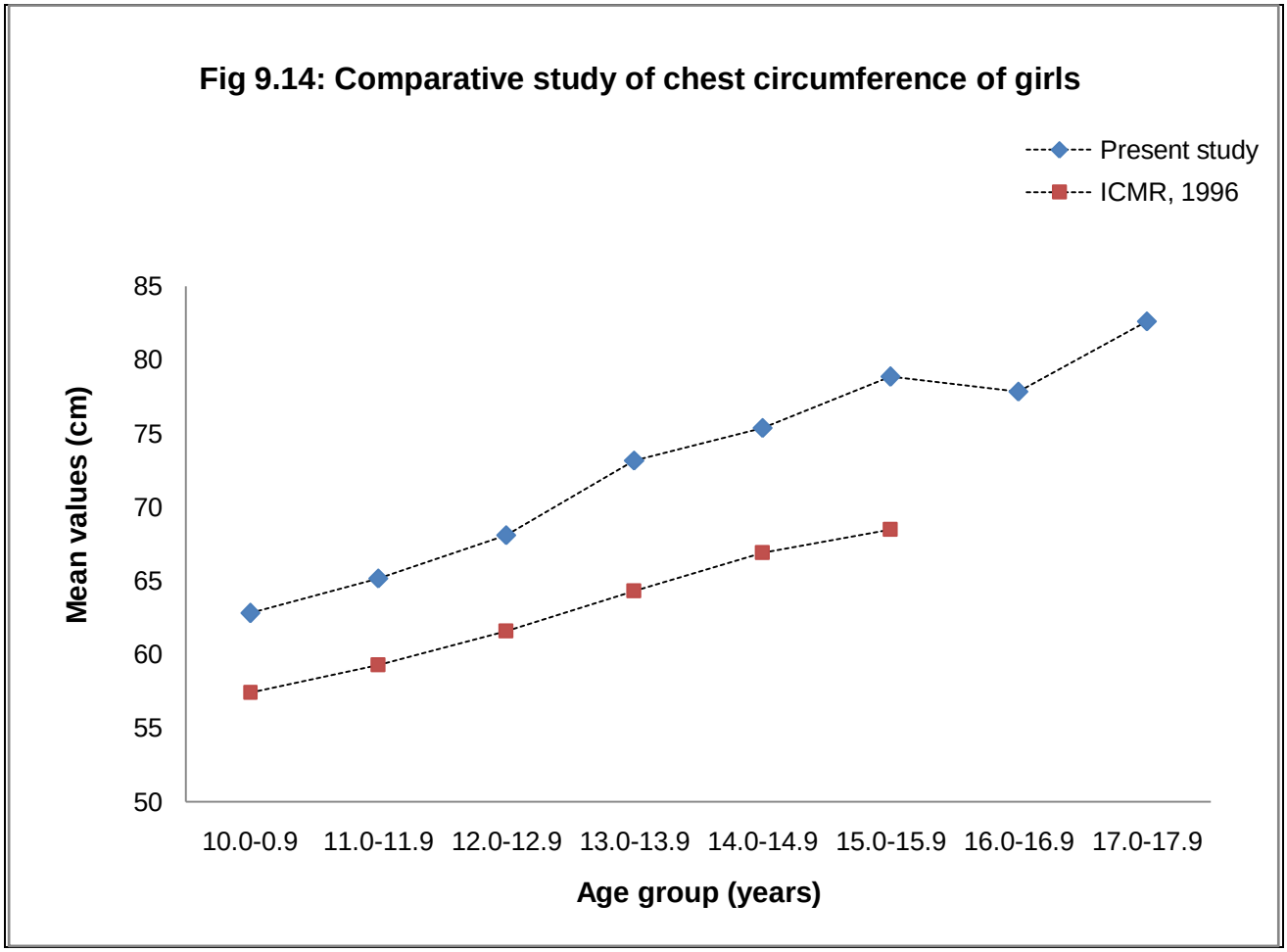


Fig 9.15: Comparative study of minimum waist circumference of boys

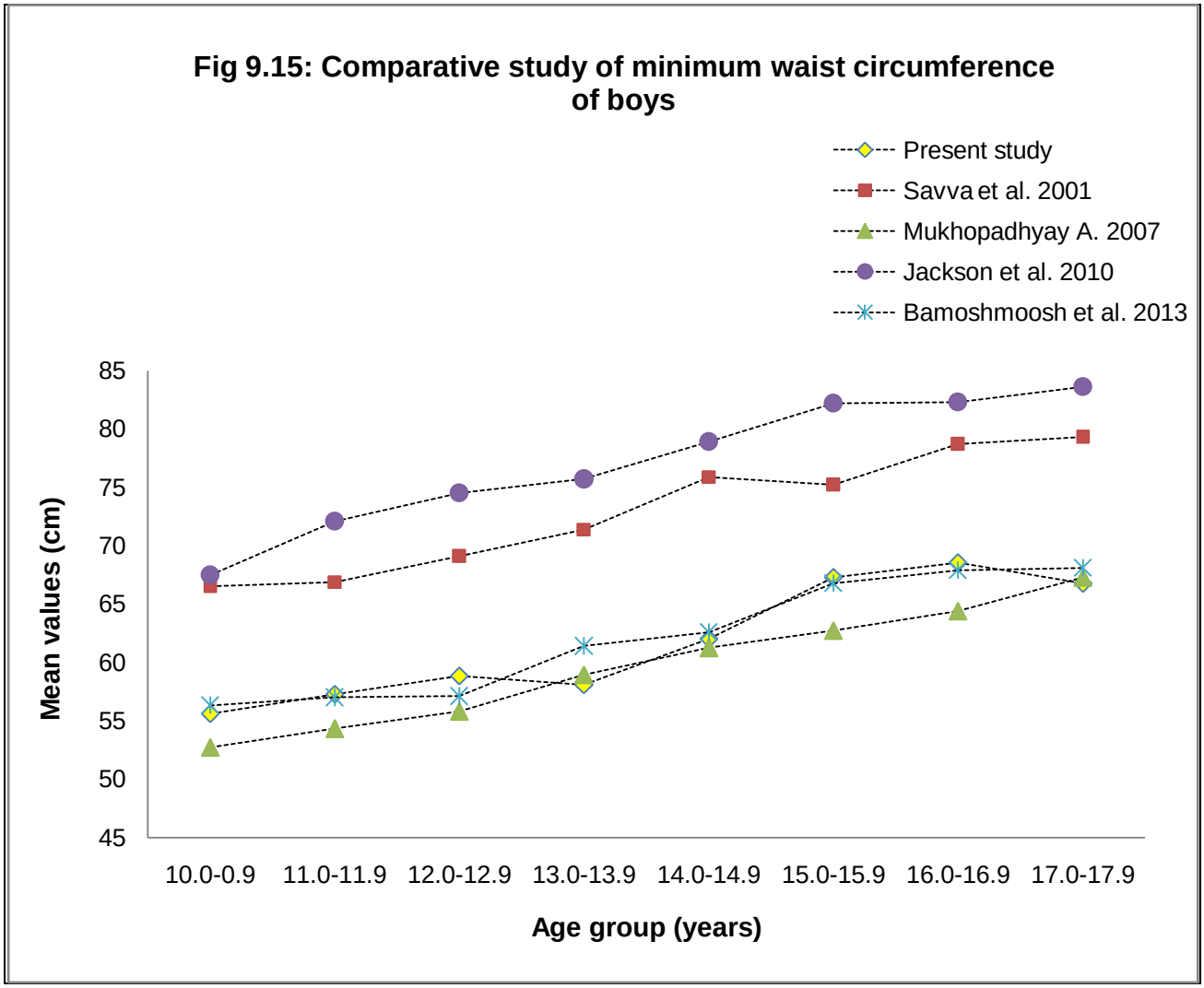


Fig 9.16: Comparative study of minimum waist circumference of girls

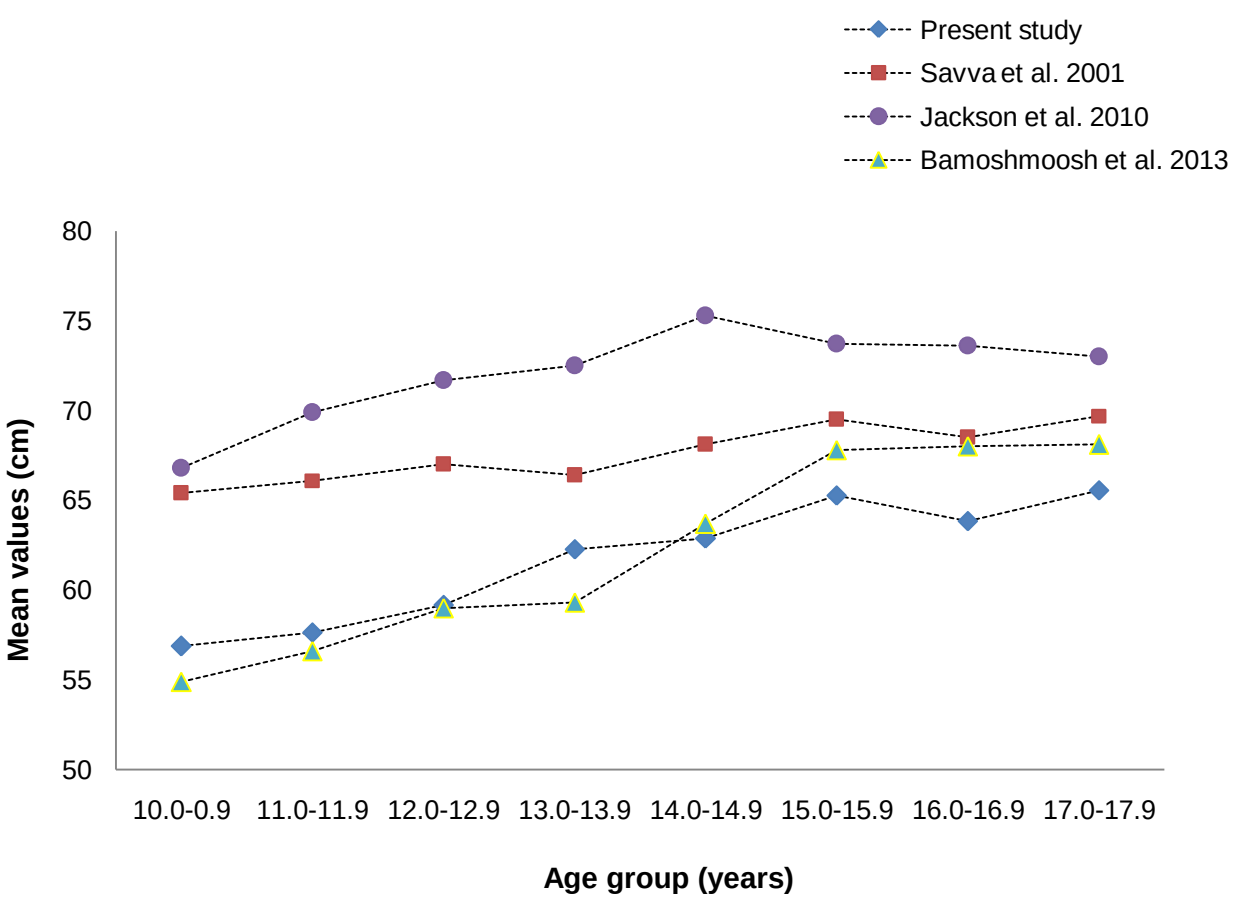


Fig 9.17: Comparative study of hip circumference of boys

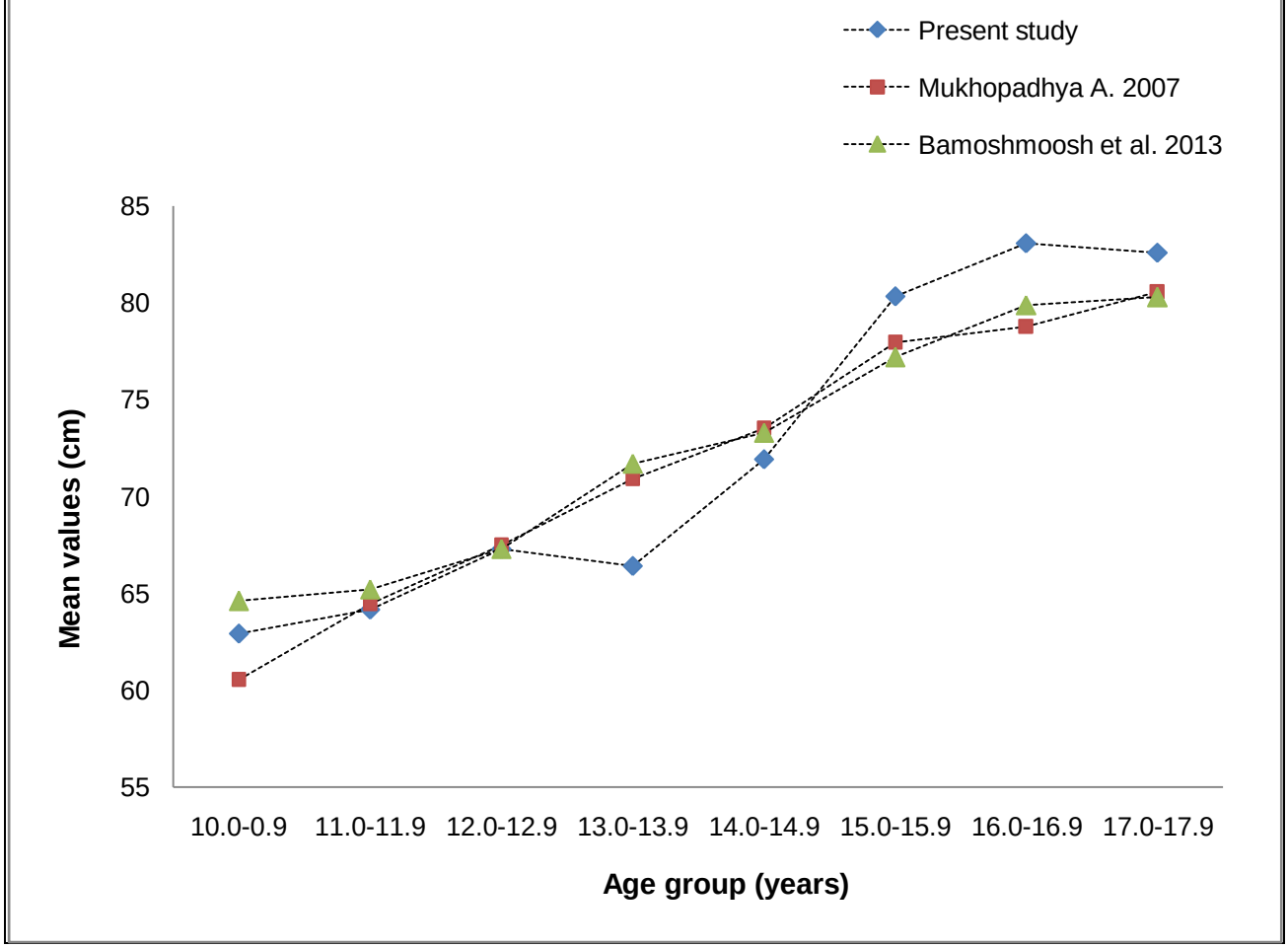


Fig 9.18: Comparative study of hip circumference of girls

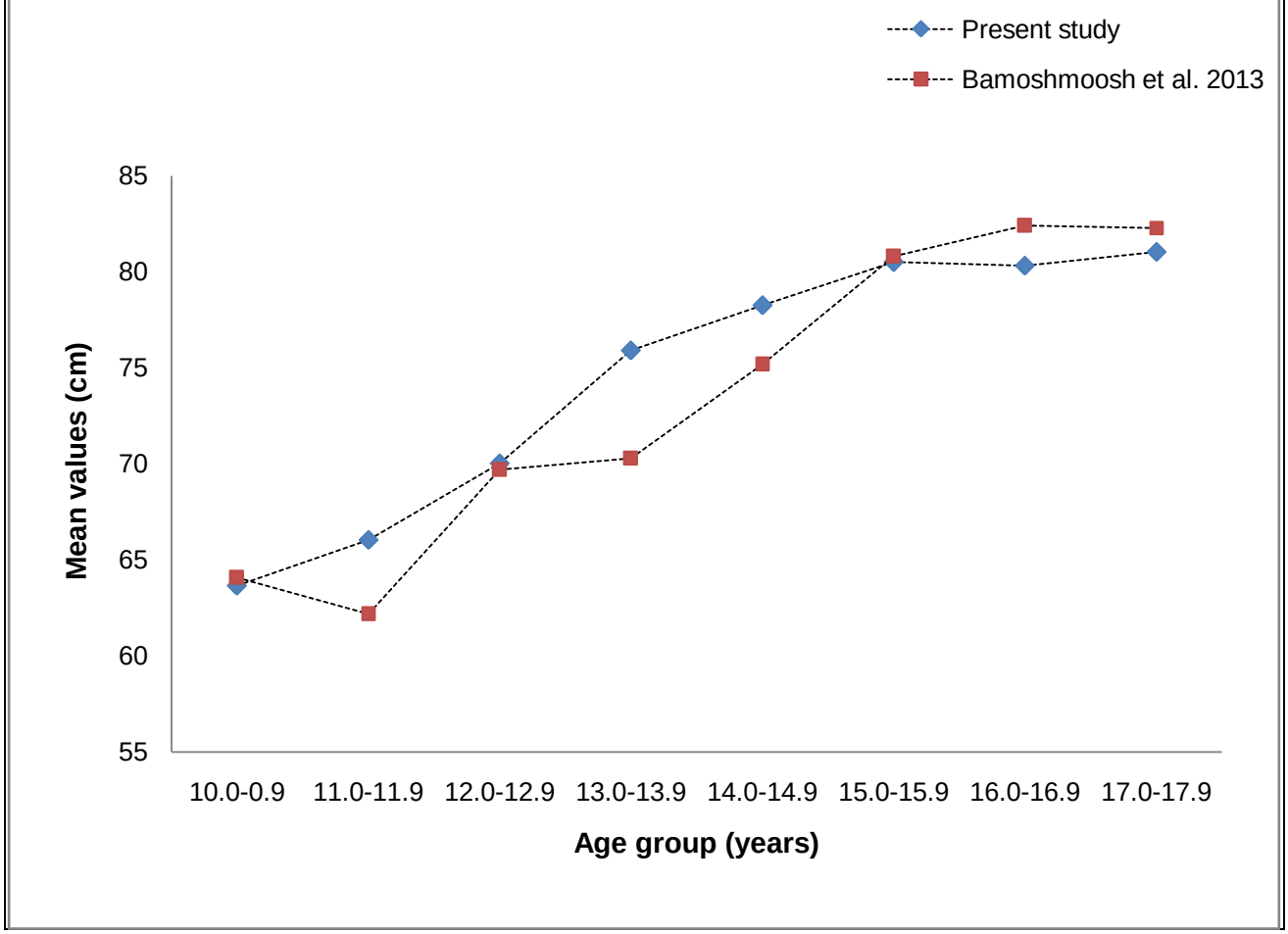


Fig 9.19: Comparative study of biceps of boys

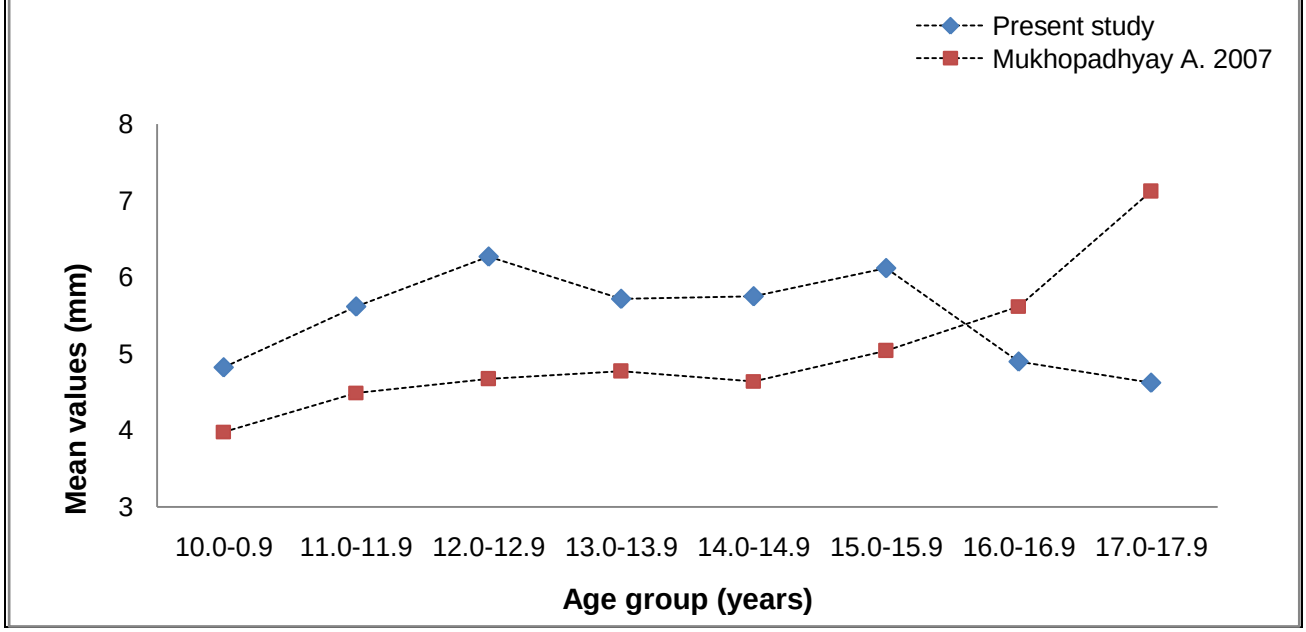


Fig 9.20: Comparative study of triceps of boys

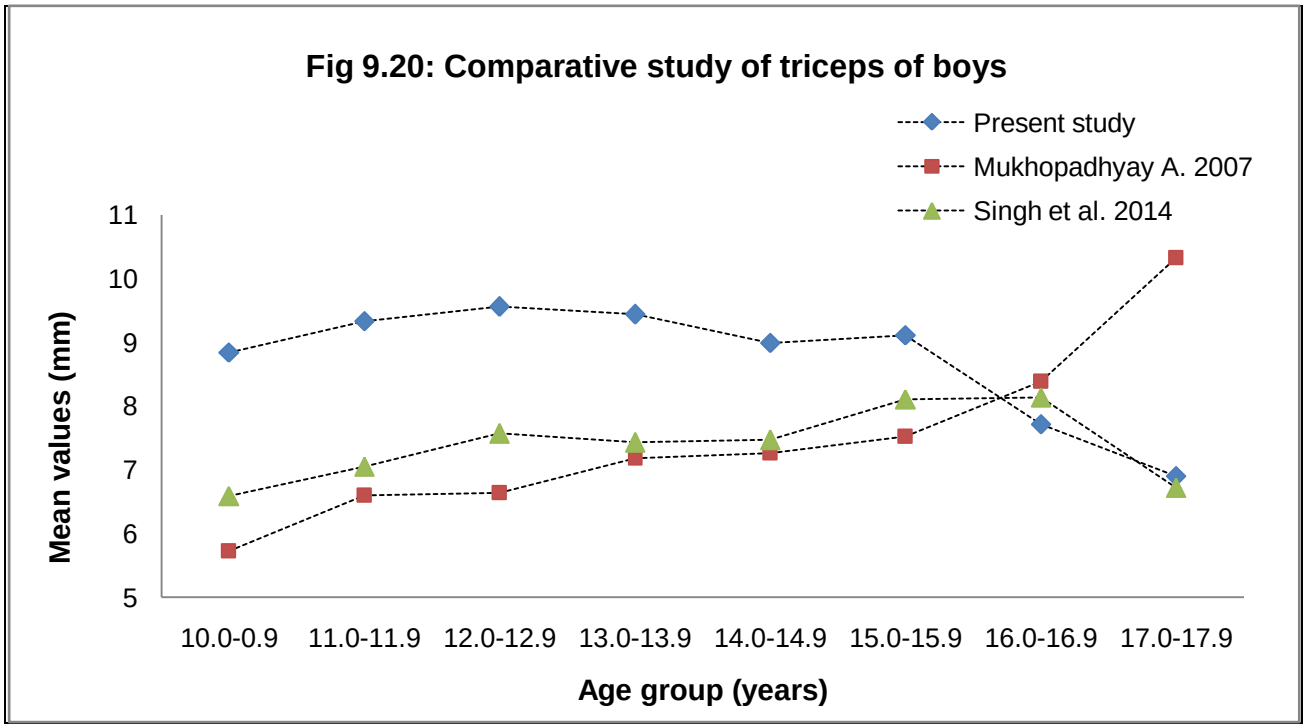


Fig 9.21: Comparative study of triceps of girls

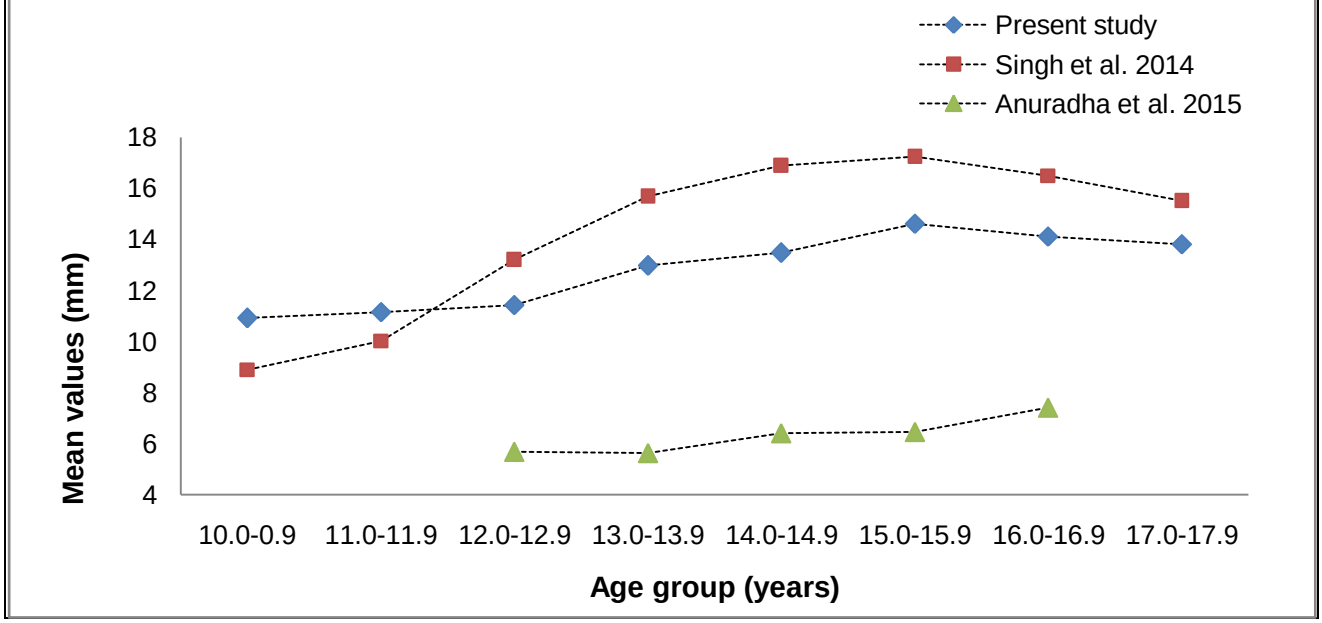


Fig 9.22: Comparative study of subscapular of boys

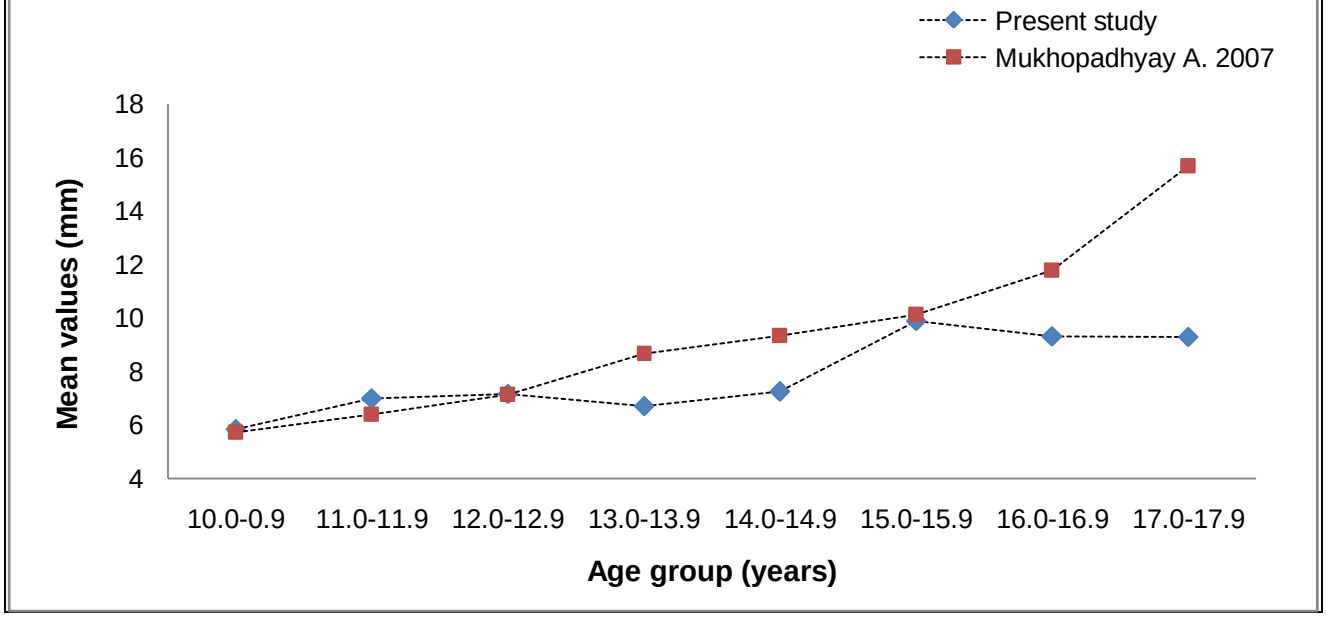


Fig 9.23: Comparative study of subscapular of girls

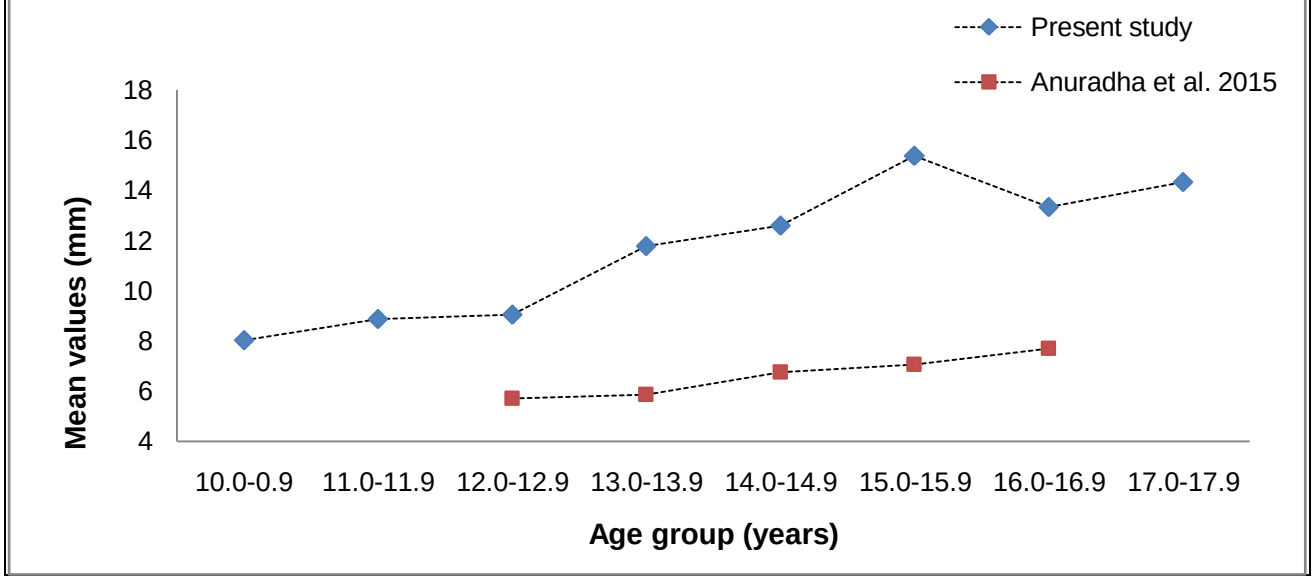
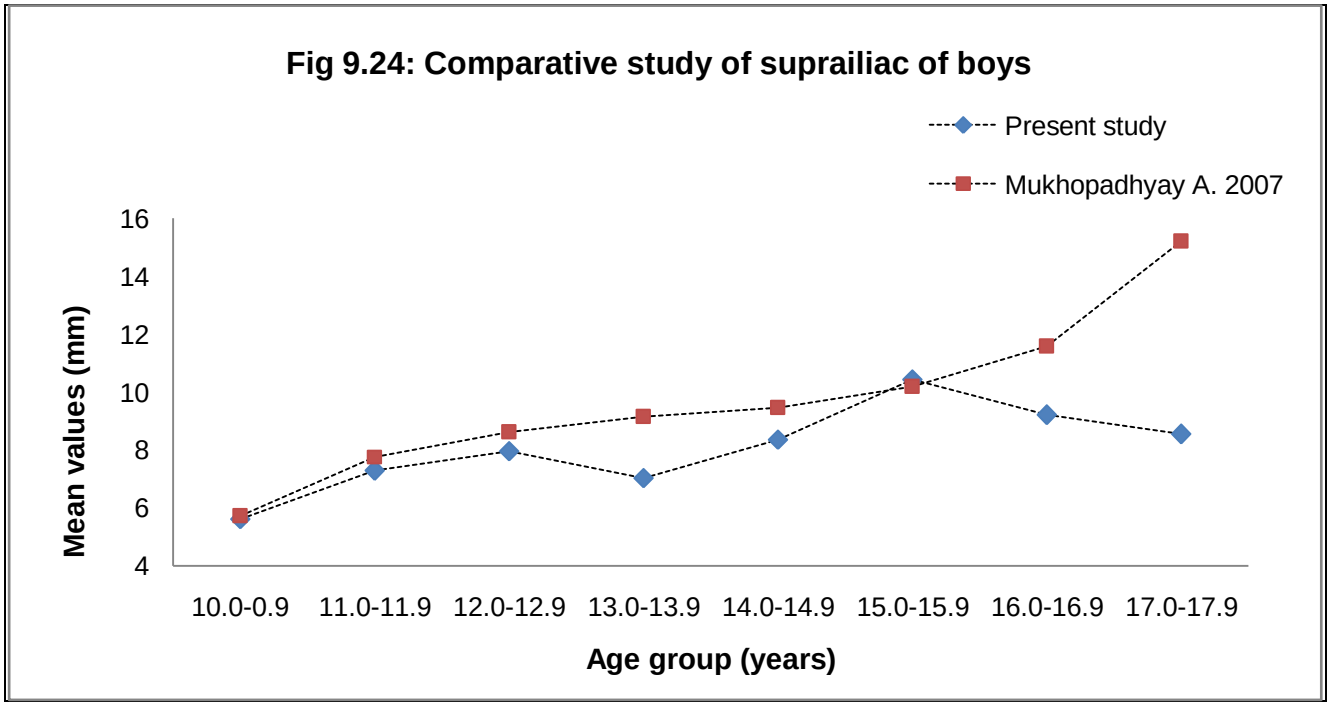


Fig 9.24: Comparative study of suprailiac of boys



9.2 ADIPOSITY AND BODY COMPOSITION

Recent investigations worldwide have explored regional adiposity, body composition and body fat distribution among children and adolescents (Musaiger et al. 2000, Okada et al. 2005, Li et al. 2005). There have been numerous anthropometric studies of Indian children (ICMR 1996), but most of them have merely concentrated on height, weight and other somatometric dimensions. A few of these studies have dealt with body composition and body fat patterning (Bhadra et al. 2001, 2005a, Mukhopadhyay et al. 2005a). Therefore, there are no population-based data available on body composition, adiposity and body fat distribution of Bengalee Muslim adolescents. Thus, the material of the present research investigation provides some pioneering findings on adiposity, subcutaneous fat patterning and body composition among the adolescent Bengalee Muslim.

For this study, as with many studies in developing countries, there is no large population based local reference data set available. Therefore, adiposity and body composition reference data had been taken from populations of well-nourished individuals from the India, Kuwait, Cyprus, Yemen. However, a complete relative judgment of the present findings with the earlier published documents has been attempted in this section but practically most of the parameters on adiposity and body composition findings could not evaluated because of scarcity of age and sex specific comparable published findings.

Adolescence is the most crucial phase of growth from birth to maturity. In this period a sudden and rapid acceleration of physical growth and development takes place (Tanner 1962). The overall and age-wise distributions in different adiposity and body composition profiles of the Bengalee adolescents provide some novel and unique information (Mukhopadhyay et al. 2005a, 2005b). There was a consistent increasing trend with maximum age of both sexes in generalised adiposity, regional adiposity (circumferences and skinfolds) and body composition in the age groups from 10 to 17 years. Recent studies have also observes similar findings among adolescents in Jamaica (Walker et al. 1996), Baharain (Musaiger et al. 2000), Japan (Tahara et al. 2002) and India (Mukhopadhyay A. 2007). These studies have also reported a consistent increasing

trend in adiposity and body composition characteristics among adolescents with the advancement of age.

On the contrary, there is a decrease in fat with age of both sexes in central body part (i.e. waist and abdominal region) as the three central adiposity indices (conicity index, waist-hip ratio and waist-height ratio) are negatively associates with age. This is because increase in hip circumference is greater than waist circumference, resulting in lower adiposity indices. This indicates a differential pattern and intensity of fat deposition at these two levels.

The net and percent increase in different adiposity and subcutaneous fat patterning (***Table 9.2***), and body composition measures (***Table 9.3***) from 10 to 17 years demonstrates distinctive differential rates of increase or decrease among Bengalee Muslim boys and girls (***Fig. 9.3 - 9.6***). Body mass index, a well established measure of generalised adiposity, indicates 20.97% increase of boys and 22.01% increase of girls from 10 to 17 years, whereas percent body fat, a widely accepted measure of total body fat content, decrease 10.29% of boys and increase 23.00% of girls during the same chronological age. The relative percent increase of boys in fat mass (46.38%) and fat free mass (52.58%) but percent increase of girls in fat mass (57.64%) and fat free mass (41.12%). It means that the fat contents among Bengalee Muslim adolescent boys decreases (6.20%) than the non-fat body components (fat free mass) and the fat contents among Bengalee Muslim adolescent girls increases (16.52%) than the non-fat body components (fat free mass). Future research should be undertaken to compare the variation in the rate of increase in fat mass than fat free mass of girls in different ethnic groups. If ethnic variation is found in these rates, they would be of immense biological anthropological interest particularly in the study of ethnic variation.

Body mass index, an excellent indicator of nutritional status and generalised adiposity measures, shows that Bengalee Muslim adolescent boys of the present study (***Table 9.22***) have remarkably lower mean values than Kuwait boys (Jackson et al. 2010) and Yemeni boys (Bamoshmoosh et al. 2013). However, two studies of West Bengal i.e. Bengalee Hindu boys (Mukhopadhyay A. 2007) and slum boys of Kolkata (Dasgupta et al. 2010) have almost similar mean values in each group to the present study. Analysis of variance reveals significant differences ($p<0.01$) among these studies in each age

group (***Fig 9.25***). Another interesting point to note that the mean body mass index value of the present samples remains almost stable from 10 to 13 years, and thereafter there is a steady incline at ages 13 to 17 years. This is probably indicating the fact that the adolescent growth spurt begins in the present Bengalee boys at age 13 years.

A comparative evaluation of Body mass index of girls of present study (***Table 9.23***) revealed that the age-wise mean values of Bengalee Muslim adolescents of girls have remarkably lower mean values in each age group than Cypriot girls (Savva et al. 2001), Indian (Bangalore city) girls (Sood et al. 2007), Kuwait girls (Jackson et al. 2010) and Yemeni girls (Bamoshmoosh et al. 2013). Analysis of variance reveals significant differences ($p<0.01$) among these studies at each age group (***Fig 9.26***). Another interesting point to note that the mean body mass index value of the present samples remains almost stable from 10 to 12 years, and thereafter there is a steady incline at ages 12 to 17 years. This is probably indicating the fact that the adolescent growth spurt begins in the present Bengalee girls at age 12 years.

On the other hand, waist-hip ratio, a conventional and widely accepted indicator of central adiposity, of the Bengalee Muslim adolescent boys (***Table 9.24***) shows quite similar age-wise pattern of change to Bengalee Hindu boys (Mukhopadhyay A. 2007) and Yemeni children (Bamoshmoosh et al. 2013). However, Greek adolescents reported by Flora et al. 2015 demonstrate lower mean values in the age group from 12 to 17 years than the Bengalee Muslim adolescent boys (***Fig. 9.27***).). Analysis of variance reveals significant differences ($p<0.01$) among these studies in the age group from 12 to 17, but the differences are not significant at the level 0.05 in the age group of 10 and 11 years.

A comparative evaluation of Waist hip ratio of girls of present study (***Table 9.25***) reveals that the age-wise mean values of Bengalee Muslim adolescents of girls are quite similar in each age group to Yemeni children reported by Bamoshmoosh et al. 2013 but greater mean values of present studies in the age group from 12 to 17 years than Greek adolescent girls reported by Flora et al. 2015 (***Fig. 9.28***). Analysis of variance reveals that the differences are statistically significant ($p<0.01$) in the age groups from 12 to 17 years. However, ANOVA could not be calculated in the age groups of 10 and 11 years due to lack of data.

A comparative evaluation of Waist height ratio of boys (***Table 9.26***) and girls (***Table 9.27***) of present study reveals that the age-wise mean values of Bengalee Muslim adolescents are quite similar in each age group to Bengalee Hindu boys (Mukhopadhyay A. 2007), Yemeni children reported by Bamoshmoosh et al. 2013 and Greek adolescents reported by Flora et al. 2015 (***Fig. 9.29*** and ***Fig. 9.30***). Analysis of variance of boys reveals that the differences are statistically significant ($p<0.01$) in each age group except in the age group of 17 years. Analysis of variance of girls reveals that the differences are statistically significant ($p<0.01$) in the age groups of 12 and 15 to 17 years but the differences are not significant at the level 0.05 in the age group of 13 and 14 years. However, ANOVA could not be calculated in the age groups of 10 and 11 years due to lack of data.

Furthermore, the boys of Pune city (Pandit et al. 2009) demonstrate greater mean values in percent body fat than the Bengalee Muslim boys (***Table 9.28***) of corresponding age group. The age wise mean values of present study are greater in each age group except in the age group of 16 and 17 years than Bengalee Hindu boys reported by Mukhopadhyay A. 2007. Analysis of variance reveals that the differences are statistically significant ($p<0.01$) in each age group. However, ANOVA could not be calculated in the age group of 17 years due to lack of data (***Fig 9.31***).

The age wise mean values of girls of present study (***Table 9.29***) of percent body fat are lower in each age group than two Indian findings (Bangalore city and Pune city) reported by sood et al. 2007 and Pandit et al. 2009. Analysis of variance reveals that the differences are statistically significant ($p<0.01$) in each age group. However, ANOVA could not be calculated in the age group of 17 years due to lack of data (***Fig 9.32***).

A comparative evaluation of fat mass of boys of present study (***Table 9.30***) reveals that the age-wise mean values of Bengalee Muslim adolescents of boys are higher in each age group except in the age group of 17 years than Bengalee Hindu boys reported by Mukhopadhyay A. 2007. The mean differences of fat mass between present studies boys and Bengalee Hindu boys are statistically significant at the 0.05 level in each age group except in the age groups of 13 and 16 years (***Fig 9.33***).

A comparative evaluation of fat free mass of boys of present study (***Table 9.31***) reveals that the age-wise mean values of Bengalee Muslim adolescents of boys are lower in the age group from 10 to 14 years but the mean values of Bengalee Muslim adolescents of boys are greater in the age group from 15 to 17 years than Bengalee Hindu boys reported by Mukhopadhyay A. 2007. The mean differences of fat free mass between present studies boys and Bengalee Hindu boys are statistically significant at the 0.05 level in each age group except in the age groups of 15 and 16 years (***Fig 9.34***).

Age trend in arm muscle circumference and arm muscle area of the Bengalee Muslim samples (***Table 9.32*** *and* ***Table 9.33***) shows that the age-wise mean values of Bengalee Muslim adolescents of boys are lower in the age group from 10 to 14 years but the mean values of Bengalee Muslim adolescents of boys are greater in the age group from 15 to 17 years than Bengalee Hindu boys reported by Mukhopadhyay A. 2007. The mean differences of AMC between present studies boys and Bengalee Hindu boys are statistically significant at the 0.05 level in each age group except in the age groups of 15 and 16 years (***Fig 9.35***). The mean differences of AMA between present studies boys and Bengalee Hindu boys are statistically significant at the 0.05 level in each age group except in the age group of 14 and 16 years ***(Fig 9.36).***

Age trend in arm fat area of the Bengalee Muslim samples (***Table 9.34***) shows that the age-wise mean values of Bengalee Muslim adolescents of boys are higher in each age group except in the age group of 16 and 17 years than Bengalee Hindu boys reported by Mukhopadhyay A. 2007. The mean differences of AFA between present studies boys and Bengalee Hindu boys are statistically significant at the 0.05 level in each age group except in the age groups of 15 and 16 years (***Fig 9.37***).

For many developing countries including India, the problem of excess body fat (overweight and obesity) and related diseases has been posing considerable concern in the field of public health owing to the emergence of epidemiological transition (Mukhopadhyay et al. 2005c). However, epidemiological studies of age and sex variations of overweight and obesity among Bengalee populations are lacking (Ghosh et al. 2004, Bhadra et al. 2005b). Further studies are needed to ascertain the likely cause(s) of this significant increment in body fat. A particularly important question to be addressed in future studies among Bengalees is whether there is a cause-effect

relationship between adolescent growth and significant increase in body fat or whether it is mediated by other confounding effects. This hypothesis can only be answered definitely with further longitudinal studies and qualitative assessments.

There is little comparative data available on ethnic differences in body composition (Yanovski et al. 1996). It has been suggested that ethnic disparity in adiposity evolves during adolescence although the specific age at which this occurs and the underlying factors are yet to be identified because of the paucity of current longitudinal cohort data among different ethnic groups (Kimm et al. 2001). Thus, ethnic variation in the adiposity and body composition is of great interest to biological anthropologists investigating human biological variation (Kimm et al. 2001, 2002).

India is a large country with vast ethnic heterogeneity. Future studies should be undertaken on other ethnic populations from diverse parts of India to determine differences in adiposity and body composition levels among adolescents. Lastly, another important area of future research is to study this phenomenon among the Indian Diaspora in comparison with the native populations in countries where there exists a sizable number of people of Indian origin. Such studies would not only generate information on ethnic differences but also identify the relative contributions of genetic and environmental factors associated with the significant change in adiposity and body composition.

Table 9.2: Net and Percent Increase / decrease in Adiposity and Subcutaneous Fat Content Measures from 10 to 17 Years

Variables	Net increase /decrease	Percent increase /decrease	Net increase /decrease	Percent increase /decrease
	Boys		Girls	
Generalised Adiposity				
Body Mass Index (kg/m^2)	3.85	20.97	4.13	22.01
Central Adiposity				
Conicity Index	-0.07	-6.25	-0.08	-7.08
Waist-Hip Ratio	-0.07	-8.64	-0.09	-11.11
Waist-Height Ratio	-0.02	-4.76	-0.03	-7.14
Regional Adiposity				
Subscapular-Triceps Ratio	0.71	51.08	0.34	31.19
Truncal-Extremity Fat Ratio	0.35	40.70	0.15	20.27
Centripetal Fat Ratio	17.41	30.35	8.26	16.33
Subcutaneous Fat Content				
Sum of 5 Skinfolds (mm)	4.36	1.27	21.88	33.26
Sum of Trunk Skinfolds (mm)	6.38	35.76	11.62	41.65
Sum of Extremity Skinfolds (mm)	-2.01	-9.65	10.26	27.08

Table 9.3: Net and Percent Increase / decrease in Body Composition Measures from 10 to 17 Years

Variables	Net increase /decrease	Percent increase /decrease	Net increase /decrease	Percent increase /decrease
	Boys		Girls	
Fat-Non Fat Composition				
Percent Body Fat (%)	-1.33	-10.29	5.04	23.00
Fat Mass (kg)	2.95	46.38	5.58	57.64
Fat Free Mass (kg)	22.45	52.58	13.83	41.12
Fat Mass Index (kg/m^2)	0.31	12.97	1.68	40.19
Fat Free Mass Index (kg/m^2)	3.54	22.17	2.46	16.86
Fat-Muscle Composition				
Arm Muscle Circumference (mm)	64.52	31.11	37.18	20.91
Arm Muscle Area (mm^2)	1812.50	52.64	949.99	37.55
Arm Fat Area (mm^2)	26.8	3.32	608.07	37.85

Table 9.22: Comparison of Age-wise Body Mass Index (kg/m^2) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Jackson et al. 2010	Mukhopadhyay A. 2007	Dasgupta et al. 2010	Bamoshmoosh et al. 2013	F- ratio
10.0-10.9	14.51 (1.00)	39.40 (12.10)	15.03 (1.29)	15.94 (2.03)	16.90 (4.10)	229.58*
11.0-11.9	14.98 (1.87)	21.40 (5.80)	15.70 (1.95)	15.44 (2.10)	16.00 (2.80)	46.33*
12.0-12.9	15.56 (3.17)	22.40 (5.90)	16.11 (2.00)	15.44 (1.90)	16.70 (3.50)	65.74*
13.0-13.9	15.18 (1.81)	22.70 (6.40)	16.36 (2.24)	17.58 (3.86)	17.20 (3.40)	67.96*
14.0-14.9	16.27 (2.19)	23.80 (6.60)	16.35 (1.92)	17.73 (3.05)	17.80 (2.90)	76.56*
15.0-15.9	18.43 (4.15)	25.20 (7.00)	17.73 (2.86)	17.13 (2.54)	18.90 (4.00)	49.96*
16.0-16.9	18.45 (2.22)	24.90 (7.10)	18.75 (2.02)	19.58 (3.61)	19.70 (3.90)	36.49*
17.0-17.9	18.36 (1.97)	25.90 (7.50)	19.68 (3.54)	20.13 (3.69)	19.70 (3.90)	33.98*

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.23: Comparison of Age-wise Body Mass Index (kg/m^2) of girls of Present Study with Other Studies

Age groups (years)	Present Study	Savva et al. 2001	Sood et al. 2007	Jackson et al. 2010	Bamoshmoosh et al. 2013	F- ratio
10.0-10.9	14.63 (1.26)	19.00 (3.90)	17.80 (5.70)	39.60 (11.50)	17.10 (3.80)	393.24*
11.0-11.9	14.78 (2.28)	19.50 (3.20)	18.90 (3.10)	22.10 (5.80)	17.20 (4.50)	40.24*
12.0-12.9	15.30 (2.42)	19.90 (3.70)	19.60 (3.40)	22.70 (5.30)	18.20 (3.60)	64.19*
13.0-13.9	17.09 (2.19)	19.90 (3.00)	20.20 (3.70)	23.40 (5.50)	18.70 (3.60)	55.69*
14.0-14.9	17.68 (2.33)	20.70 (3.20)	20.50 (3.70)	24.70 (6.30)	19.90 (3.30)	70.43*
15.0-15.9	19.05 (3.07)	21.50 (3.10)	20.90 (3.20)	24.30 (5.90)	20.30 (3.90)	46.04*
16.0-16.9	18.27 (2.30)	21.20 (2.90)	21.40 (3.10)	23.80 (5.50)	21.10 (3.50)	31.73*
17.0-17.9	18.76 (2.22)	21.50 (3.40)	21.50 (3.30)	24.30 (5.50)	20.00 (3.10)	32.81*

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.24: Comparison of Age-wise Waist - Hip Ratio of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	Bamoshmoosh et al. 2013	Flora et al. 2015	F- ratio
10.0-10.9	0.88 (0.04)	0.87 (0.04)	0.88 (0.09)	--	0.54 ns
11.0-11.9	0.89 (0.07)	0.85 (0.05)	0.88 (0.07)	--	5.76 ns
12.0-12.9	0.87 (0.04)	0.83 (0.04)	0.85 (0.07)	0.80 (0.06)	26.60*
13.0-13.9	0.87 (0.05)	0.83 (0.04)	0.86 (0.07)	0.80 (0.07)	31.00*
14.0-14.9	0.86 (0.05)	0.83 (0.06)	0.86 (0.07)	0.79 (0.05)	33.21*
15.0-15.9	0.84 (0.05)	0.80 (0.05)	0.87 (0.08)	0.77 (0.05)	54.68*
16.0-16.9	0.82 (0.04)	0.82 (0.04)	0.85 (0.10)	0.78 (0.06)	19.06*
17.0-17.9	0.81 (0.05)	0.83 (0.07)	0.85 (0.08)	0.77 (0.06)	21.66*

Standard deviations are presented in parentheses
ns – not significant at the 0.05 level
* - significant at the 0.01 level

Table 9.25: Comparison of Age-wise Waist - Hip Ratio of girls of Present Study with Other Studies

Age groups (years)	Present Study	Bamoshmoosh et al. 2013	Flora et al. 2015	F- ratio
10.0-10.9	0.90 (0.07)	0.86 (0.07)	--	--
11.0-11.9	0.86 (0.11)	0.86 (0.10)	--	--
12.0-12.9	0.85 (0.06)	0.85 (0.08)	0.76 (0.06)	77.88*
13.0-13.9	0.82 (0.05)	0.85 (0.07)	0.74 (0.05)	136.91*
14.0-14.9	0.80 (0.05)	0.86 (0.10)	0.74 (0.08)	64.21*
15.0-15.9	0.81 (0.06)	0.84 (0.08)	0.71 (0.04)	185.80*
16.0-16.9	0.80 (0.08)	0.83 (0.10)	0.71 (0.04)	106.43*
17.0-17.9	0.81 (0.05)	0.83 (0.08)	0.71 (0.04)	135.30*

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.26: Comparison of Age-wise Waist – Height Ratio of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	Bamoshmoosh et al. 2013	Flora et al. 2015	F- ratio
10.0-10.9	0.44 (0.02)	0.41 (0.02)	0.45 (0.06)	--	19.00*
11.0-11.9	0.44 (0.04)	0.41 (0.02)	0.44 (0.05)	--	10.42*
12.0-12.9	0.43 (0.05)	0.40 (0.02)	0.43 (0.06)	0.45 (0.06)	15.36*
13.0-13.9	0.43 (0.03)	0.40 (0.03)	0.43 (0.05)	0.45 (0.06)	24.53*
14.0-14.9	0.43 (0.03)	0.40 (0.03)	0.42 (0.05)	0.44 (0.05)	11.19*
15.0-15.9	0.43 (0.06)	0.40 (0.05)	0.45 (0.06)	0.43 (0.05)	10.35*
16.0-16.9	0.42 (0.03)	0.40 (0.03)	0.44 (0.06)	0.43 (0.05)	9.12*
17.0-17.9	0.41 (0.03)	0.43 (0.06)	0.43 (0.06)	0.42 (0.04)	2.02 ns

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.27: Comparison of Age-wise Waist – Height Ratio of girls of Present Study with Other Studies

Age groups (years)	Present Study	Bamoshmoosh et al. 2013	Flora et al. 2015	F- ratio
10.0-10.9	0.45 (0.03)	0.45 (0.07)	--	--
11.0-11.9	0.43 (0.06)	0.43 (0.07)	--	--
12.0-12.9	0.42 (0.04)	0.44 (0.06)	0.43 (0.05)	3.51**
13.0-13.9	0.42 (0.04)	0.43 (0.07)	0.43 (0.05)	0.98 ns
14.0-14.9	0.42 (0.04)	0.44 (0.06)	0.43 (0.06)	3.20 ns
15.0-15.9	0.43 (0.05)	0.46 (0.05)	0.42 (0.04)	25.83*
16.0-16.9	0.42 (0.04)	0.45 (0.06)	0.42 (0.04)	14.94*
17.0-17.9	0.43 (0.04)	0.45 (0.06)	0.42 (0.05)	9.43*

Standard deviations are presented in parentheses
ns- not significant at the 0.05 level
* - significant at the 0.01 level
** - significant at the 0.05 level

Table 9.28: Comparison of Age-wise Percent Body Fat (%) of boys of Present Study with Other Studies

Age groups (years)	Present Study	Mukhopadhyay A. 2007	Pandit et al. 2009	F- ratio
10.0-10.9	14.25 (2.29)	9.67 (2.21)	23.50 (2.20)	380.70*
11.0-11.9	15.42 (4.30)	11.33 (3.40)	25.80 (2.30)	205.45*
12.0-12.9	16.01 (5.15)	11.39 (2.57)	29.60 (2.30)	319.52*
13.0-13.9	15.72 (3.97)	12.35 (3.38)	23.00 (1.90)	176.94*
14.0-14.9	15.95 (3.52)	12.48 (3.04)	20.60 (2.30)	69.76*
15.0-15.9	16.57 (5.98)	13.20 (6.02)	20.10 (2.30)	15.03*
16.0-16.9	14.32 (4.26)	14.35 (4.97)	20.50 (1.40)	15.74*
17.0-17.9	12.92 (2.51)	17.83 (9.85)	--	--

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.29: Comparison of Age-wise Percent Body Fat (%) of girls of Present Study with Other Studies

Age groups (years)	Present Study	Sood et al. 2007	Pandit et al. 2009	F- ratio
10.0-10.9	16.87 (3.55)	17.60 (7.20)	30.60 (2.30)	70.91*
11.0-11.9	17.74 (4.72)	20.40 (7.70)	32.80 (2.40)	55.87*
12.0-12.9	17.96 (4.78)	22.30 (8.10)	36.60 (2.70)	38.91*
13.0-13.9	20.51 (3.97)	24.20 (8.60)	36.60 (2.60)	35.47*
14.0-14.9	21.13 (4.99)	24.90 (8.50)	39.60 (3.40)	43.14*
15.0-15.9	22.92 (5.30)	25.80 (7.50)	35.40 (3.10)	16.76*
16.0-16.9	21.85 (4.59)	26.10 (7.10)	36.50 (2.00)	24.49*
17.0-17.9	21.91 (4.55)	26.60 (6.90)	--	

Standard deviations are presented in parentheses
* - significant at the 0.01 level

Table 9.30: Comparison of Age-wise Fat Mass (kg) of boys of Present Study with Other Study

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T- test
10.0-10.9	3.41 (0.98)	2.74 (0.88)	4.09*
11.0-11.9	4.16 (1.93)	3.20 (1.51)	2.94*
12.0-12.9	4.99 (3.86)	3.57 (1.24)	3.22*
13.0-13.9	4.58 (1.97)	4.44 (2.02)	0.48 ns
14.0-14.9	5.65 (2.14)	4.92 (1.91)	2.09*
15.0-15.9	8.02 (4.72)	6.12 (4.42)	2.33*
16.0-16.9	7.34 (3.14)	7.05 (3.26)	0.49 ns
17.0-17.9	6.36 (1.53)	9.62 (8.07)	2.67*

Standard deviations are presented in parentheses
ns- not significant at the 0.05 level
* - significant at the 0.05 level

Table 9.31: Comparison of Age-wise Fat Free Mass (kg) of boys of Present Study with Other Study

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T- test
10.0-10.9	20.25 (1.81)	22.54 (3.29)	4.70*
11.0-11.9	21.85 (2.63)	24.31 (4.15)	3.87*
12.0-12.9	23.99 (4.47)	27.31 (4.95)	4.26*
13.0-13.9	23.70 (3.44)	30.46 (5.56)	9.52*
14.0-14.9	29.30 (6.30)	33.83 (6.21)	4.24*
15.0-15.9	38.08 (7.23)	38.03 (5.59)	0.04 ns
16.0-16.9	42.74 (4.97)	40.74 (6.19)	1.93 ns
17.0-17.9	42.70 (4.72)	39.59 (5.53)	2.52*

Standard deviations are presented in parentheses
ns-not significant at the 0.05 level
* - significant at the 0.05 level

Table 9.32: Comparison of Age-wise Arm Muscle Circumference (mm) of boys of Present Study with Other Study

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T- test
10.0-10.9	142.89 (9.11)	152.89 (17.23)	3.94*
11.0-11.9	146.08 (11.89)	155.48 (13.63)	3.97*
12.0-12.9	153.50 (19.19)	162.64 (18.99)	2.92*
13.0-13.9	150.88 (14.86)	171.35 (23.46)	6.80*
14.0-14.9	166.64 (19.86)	173.45 (18.20)	2.08*
15.0-15.9	190.27 (22.51)	189.38 (21.12)	0.23 ns
16.0-16.9	203.76 (16.39)	202.01 (26.22)	0.44 ns
17.0-17.9	207.41 (16.43)	198.49 (17.88)	2.14*

Standard deviations are presented in parentheses
ns- not significant at the 0.05level
* - significant at the 0.05 level

Table 9.33: Comparison of Age-wise Arm Muscle Area (mm^2) of boys of Present Study with Other Study

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T- test
10.0-10.9	1630.64 (212.52)	1882.72 (439.57)	4.05*
11.0-11.9	1708.60 (285.28)	1937.53 (337.30)	3.96*
12.0-12.9	1903.20 (543.19)	2132.39 (480.52)	2.75*
13.0-13.9	1828.06 (394.91)	2379.03 (650.05)	6.66*
14.0-14.9	2240.01 (551.53)	2419.09 (512.91)	1.90 ns
15.0-15.9	2919.37 (684.12)	2887.58 (673.72)	0.26 ns
16.0-16.9	3323.59 (541.37)	3299.76 (818.52)	0.19 ns
17.0-17.9	3443.14 (546.19)	3158.52 (591.34)	2.06*

Standard deviations are presented in parentheses
ns- not significant at the 0.05 level
* - significant at the 0.05 level

Table 9.34: Comparison of Age-wise Arm Fat Area (mm^2) of boys of Present Study with Other Study

Age groups (years)	Present Study	Mukhopadhyay A. 2007	T- test
10.0-10.9	781.43 (232.81)	505.88 (188.36)	7.46*
11.0-11.9	862.50 (384.26)	604.24 (285.42)	4.04*
12.0-12.9	947.34 (617.48)	623.71 (183.05)	4.63*
13.0-13.9	896.05 (376.13)	720.43 (335.79)	3.39*
14.0-14.9	911.44 (366.48)	737.43 (294.05)	3.01*
15.0-15.9	1063.52 (654.64)	849.17 (569.64)	1.95 ns
16.0-16.9	922.50 (511.40)	1005.81 (465.02)	0.92 ns
17.0-17.9	808.23 (237.24)	1292.35 (920.93)	3.39*

Standard deviations are presented in parentheses
ns- not significant at the 0.05 level
* - significant at the 0.05 level

Fig 9.3: Percent Increase / decrease in adiosity and subcutaneous fat content from 10 to 17 Years of boys

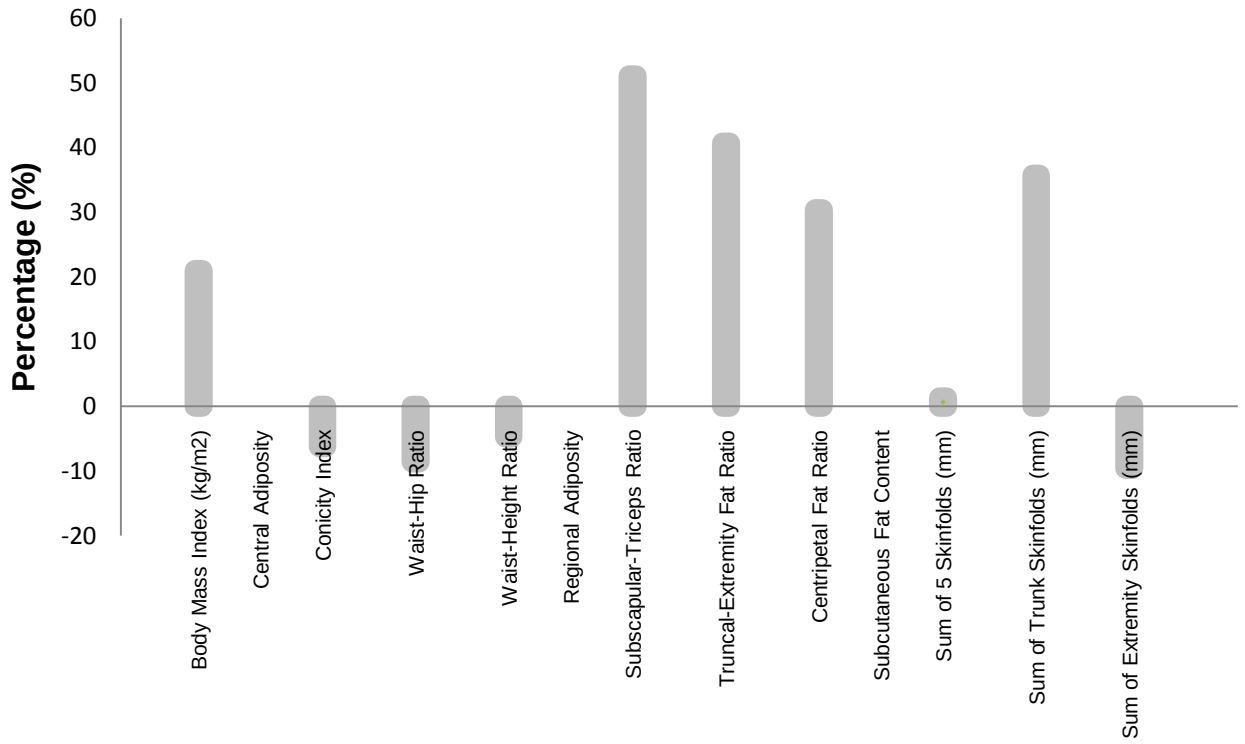


Fig 9.4: Percent Increase / decrease in adiposity and subcontaneous fat content from 10 to 17 Years of girls

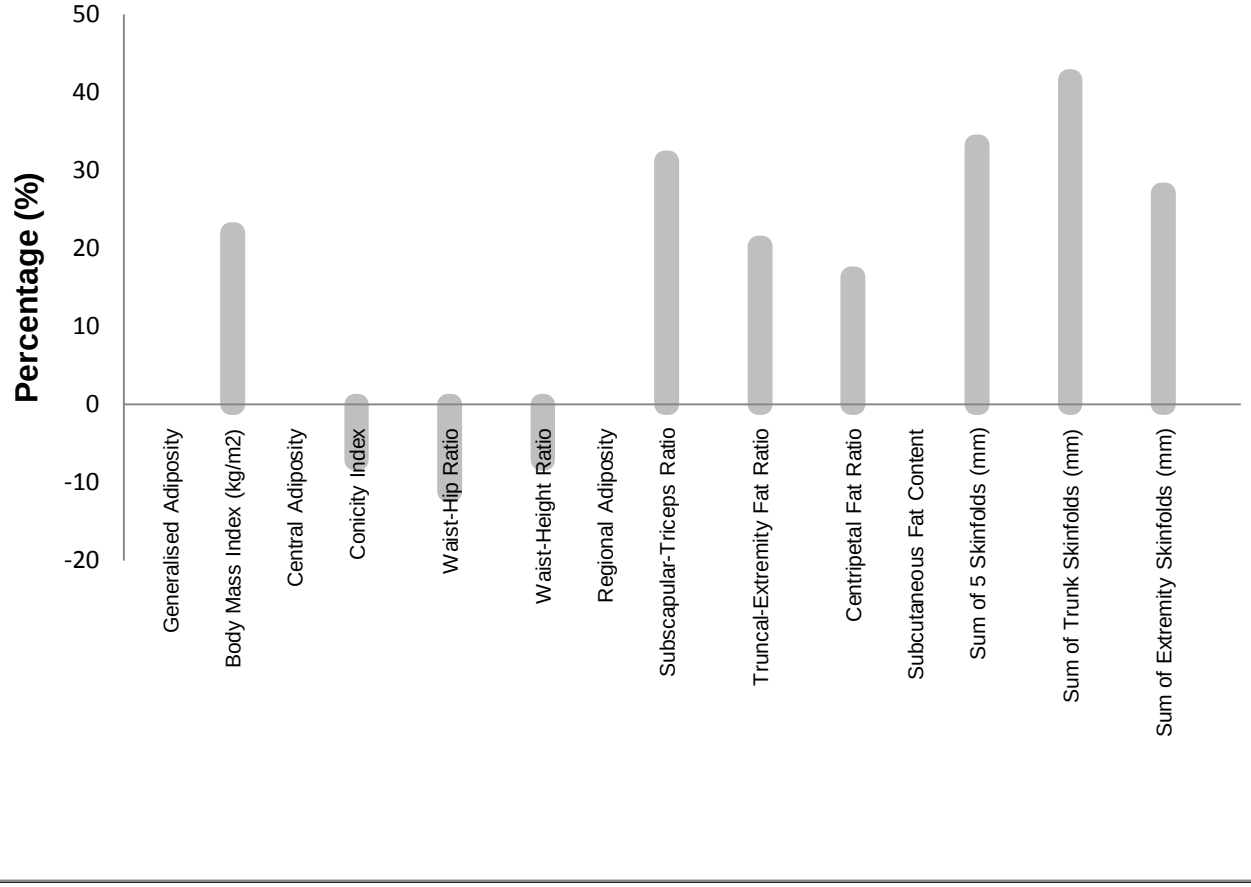


Fig 9.5: Percent Increase / decrease in Body Composition Measures from 10 to 17 Years of boys

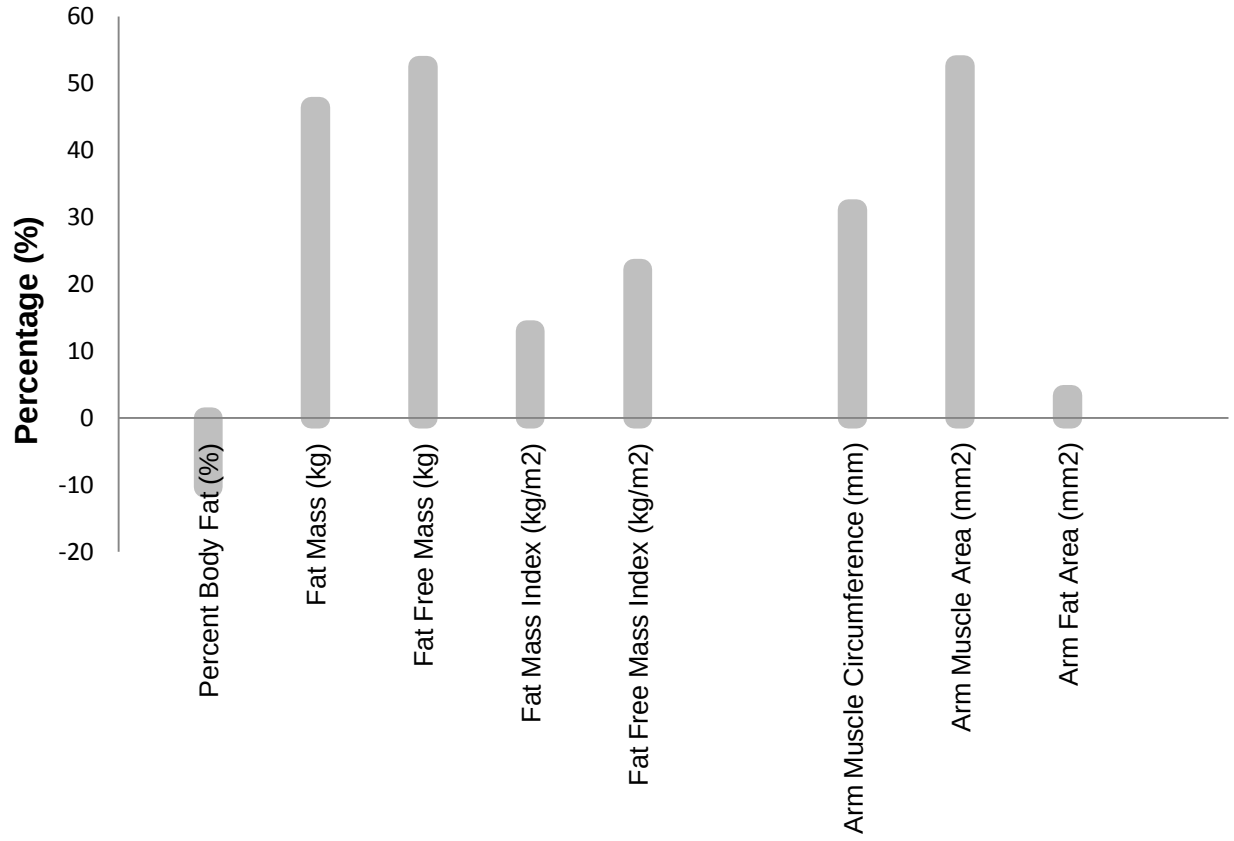


Fig 9.6: Net and Percent Increase / decrease in Body Composition Measures from 10 to 17 Years of girls

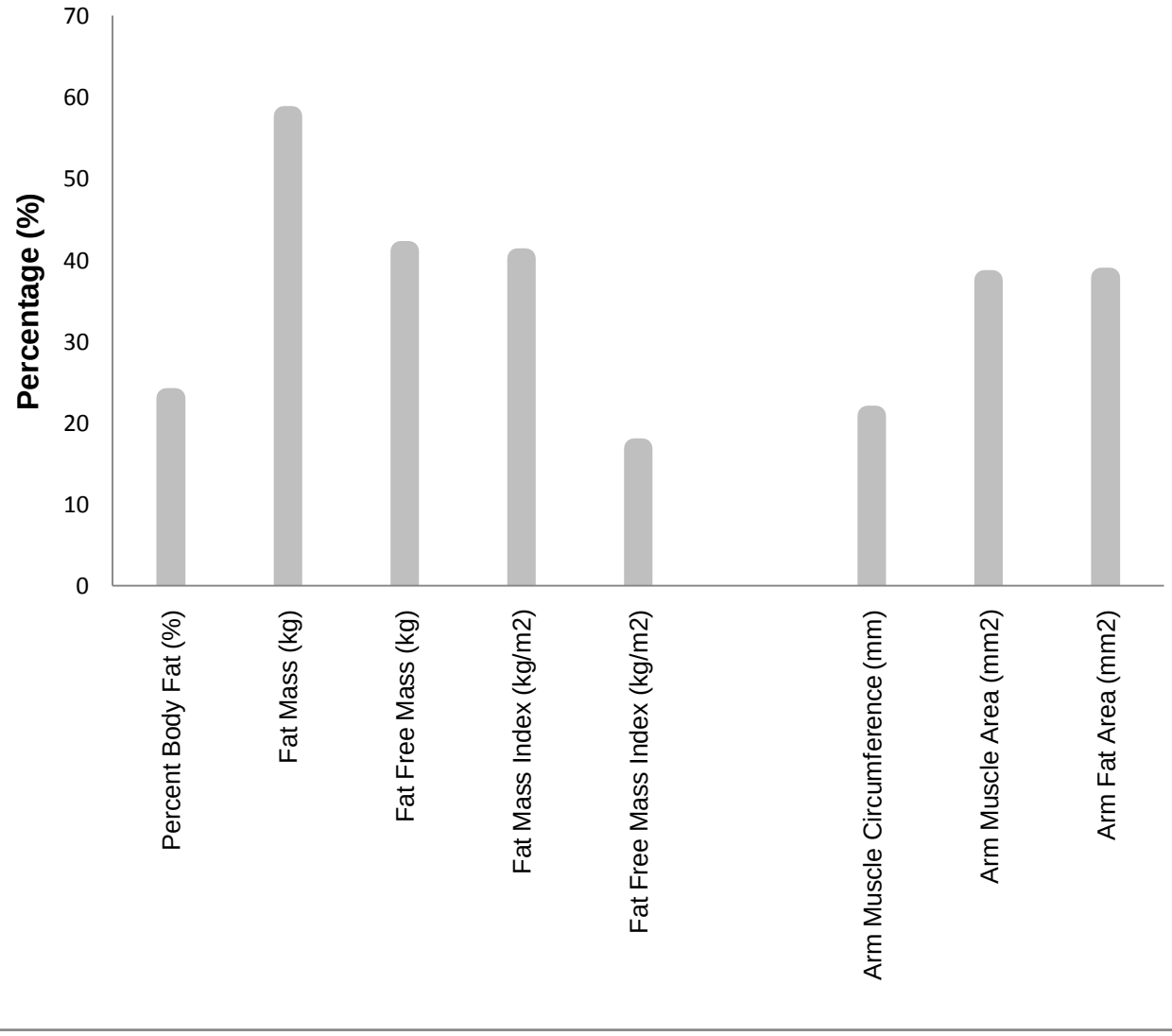


Fig 9.25: Comparative study of body mass index of boys

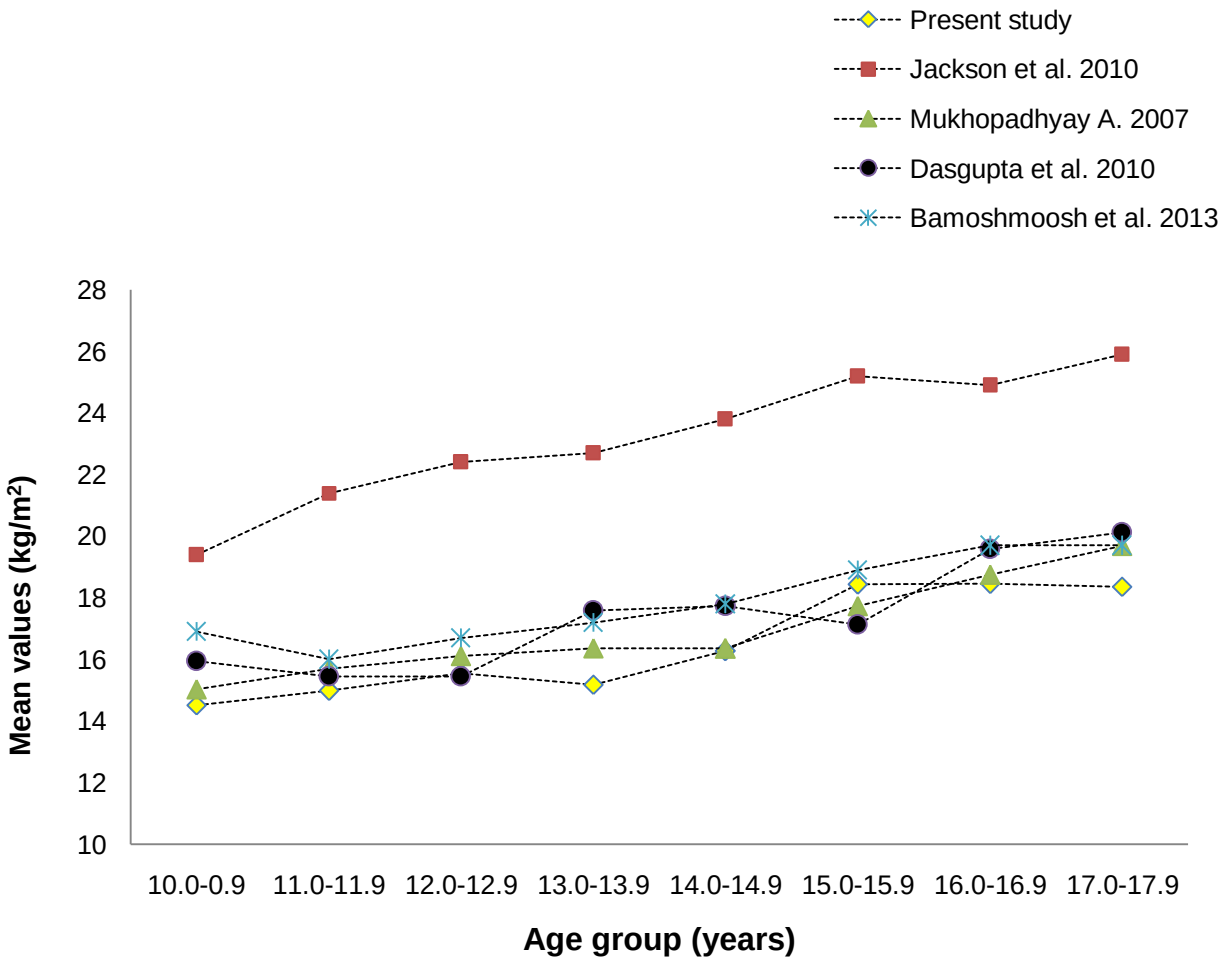


Fig 9.26: Comparative study of body mass index of girls

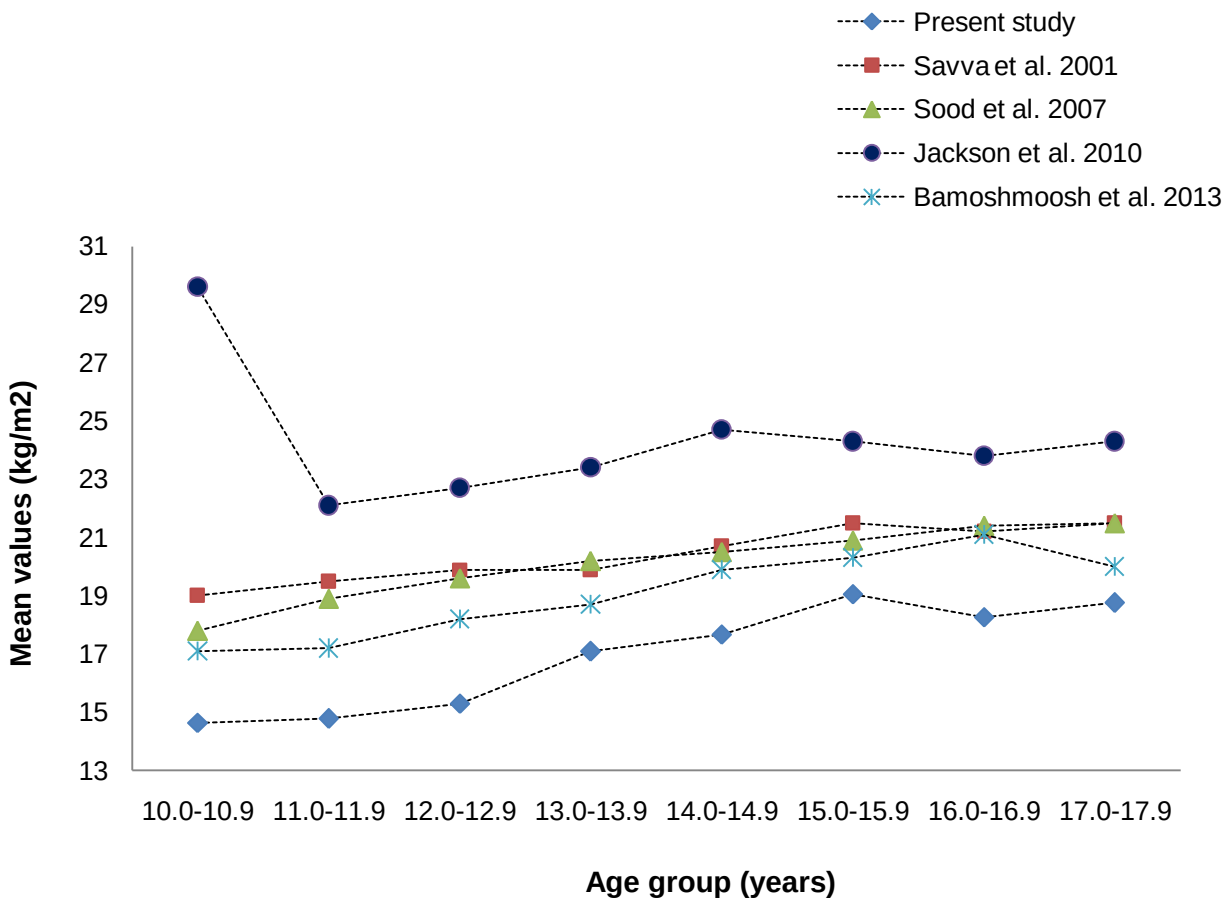


Fig 9.27: Comparative study of waist- hip ratio of boys

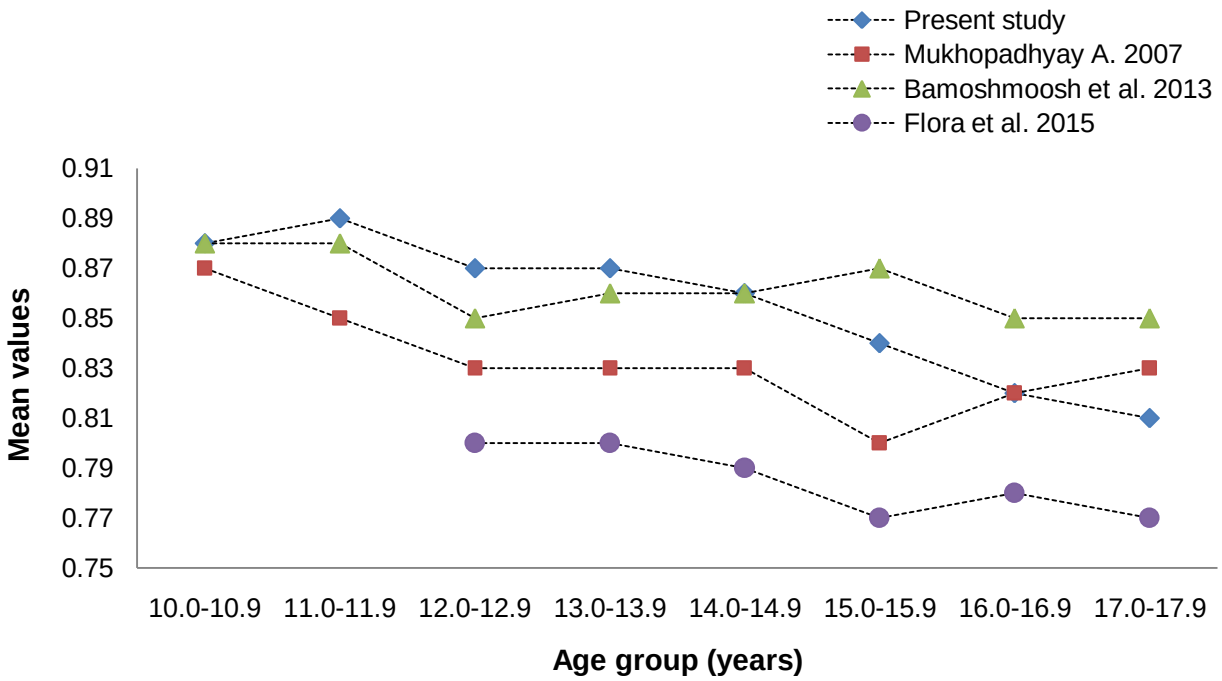


Fig 9.28: Comparative study of waist - hip ratio of girls

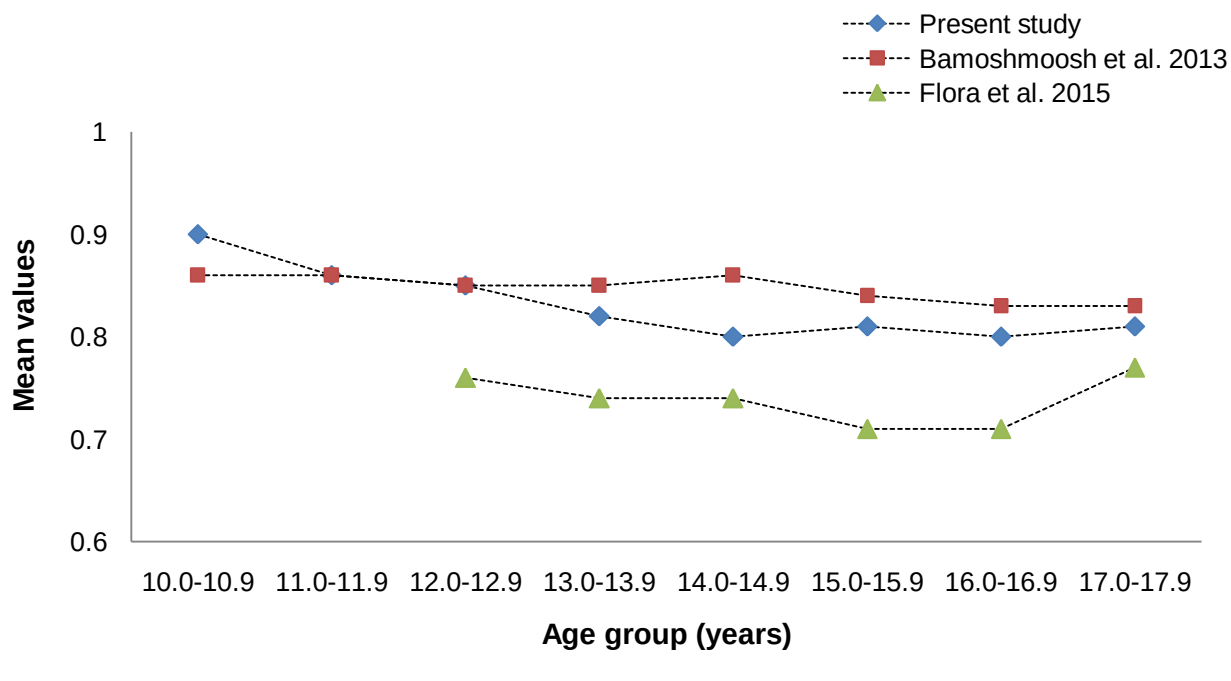


Fig 9.29: Comparative study of waist- height ratio of boys

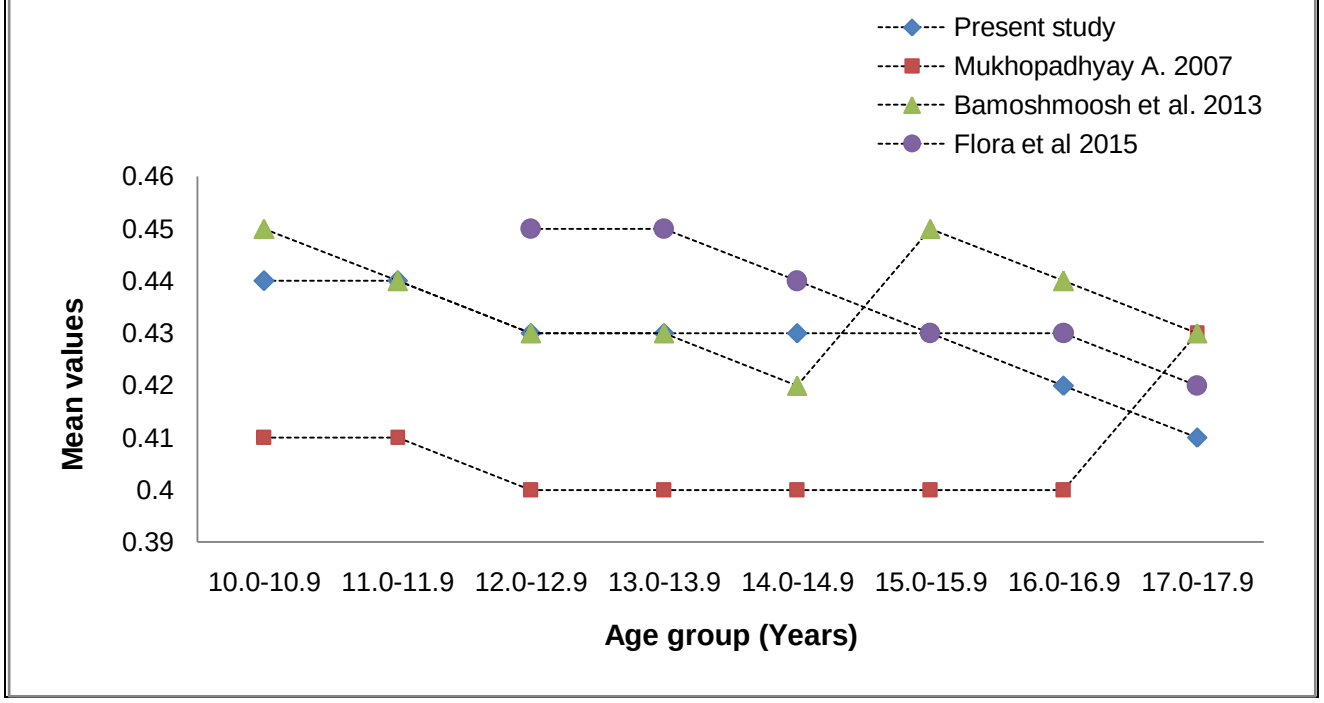


Fig 9.30: Comparative study of waist- height ratio of girls

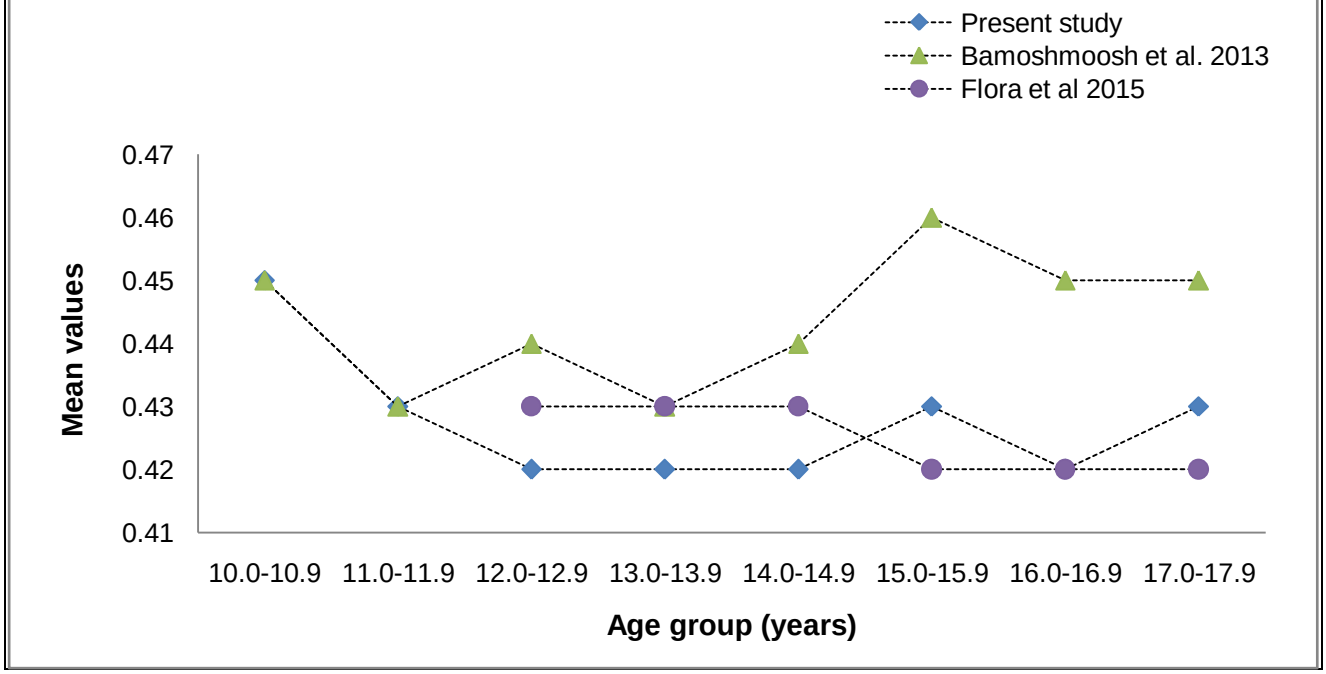


Fig 9.31: Comparative study of percent body fat (%) of boys

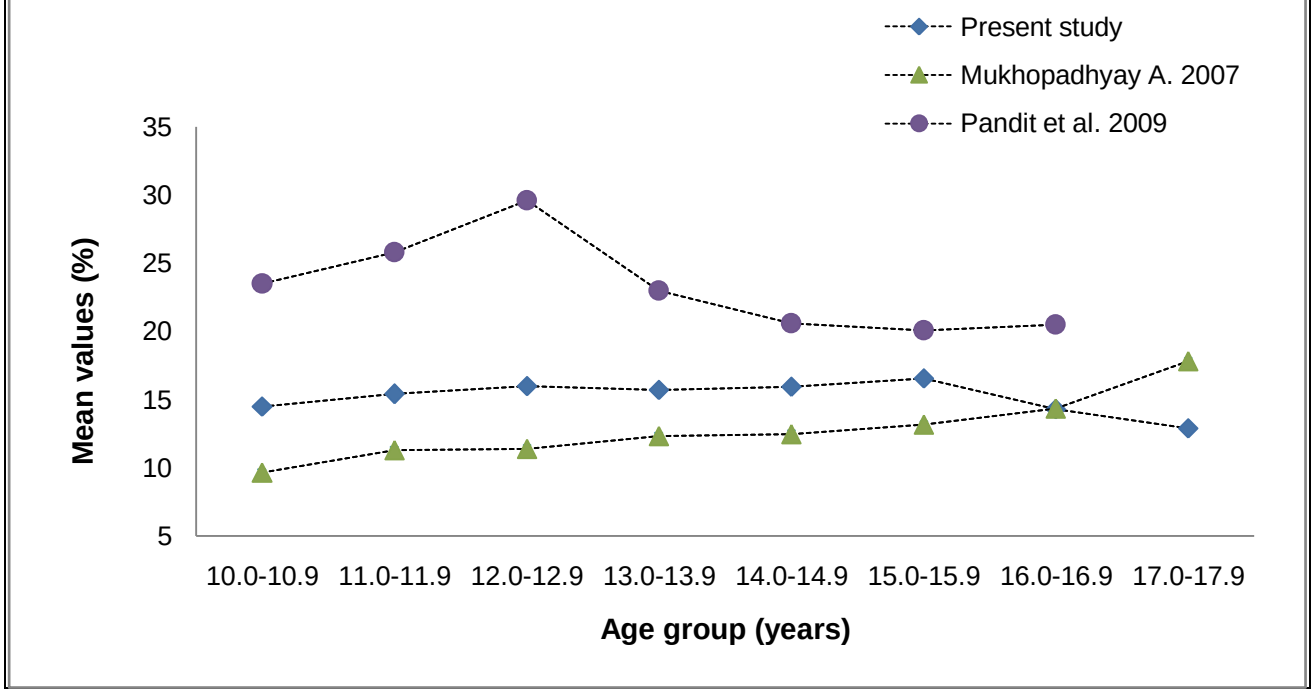


Fig 9.32: Comparative study of percent body fat (%) of girls

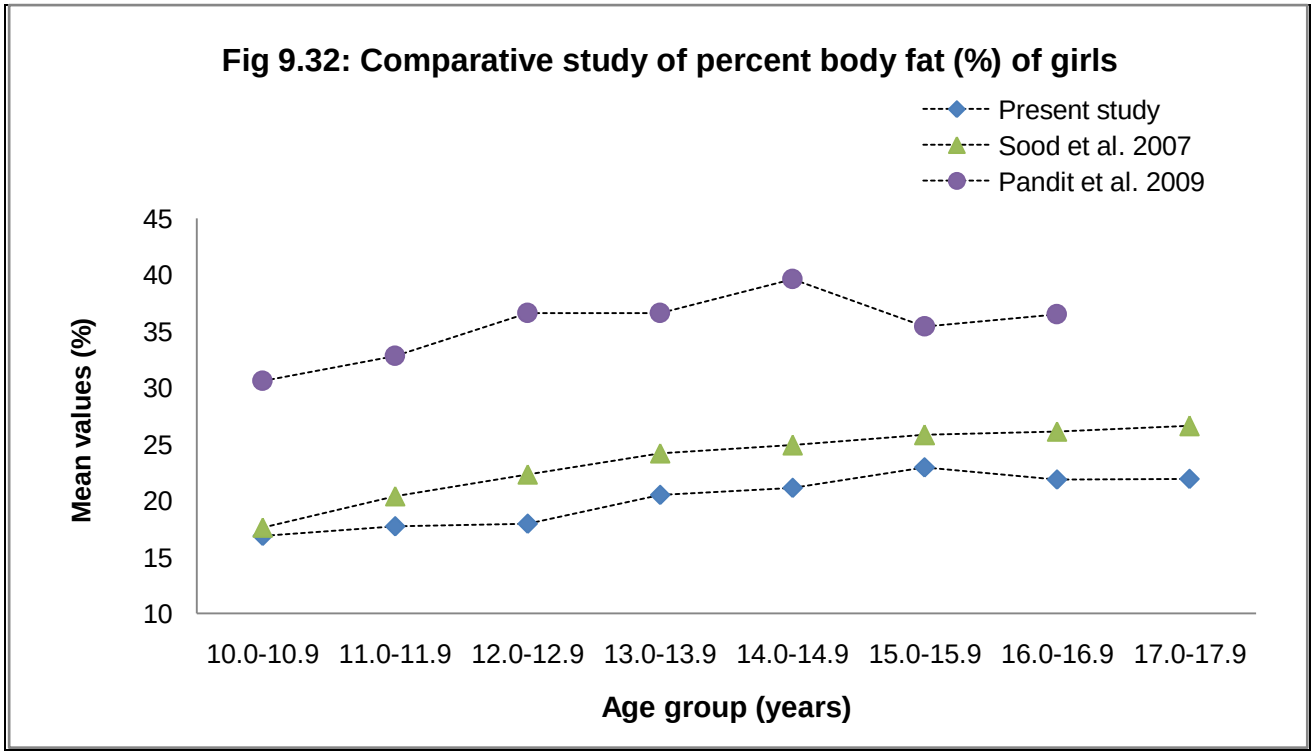


Fig 9.33: Comparative study of fat mass of boys

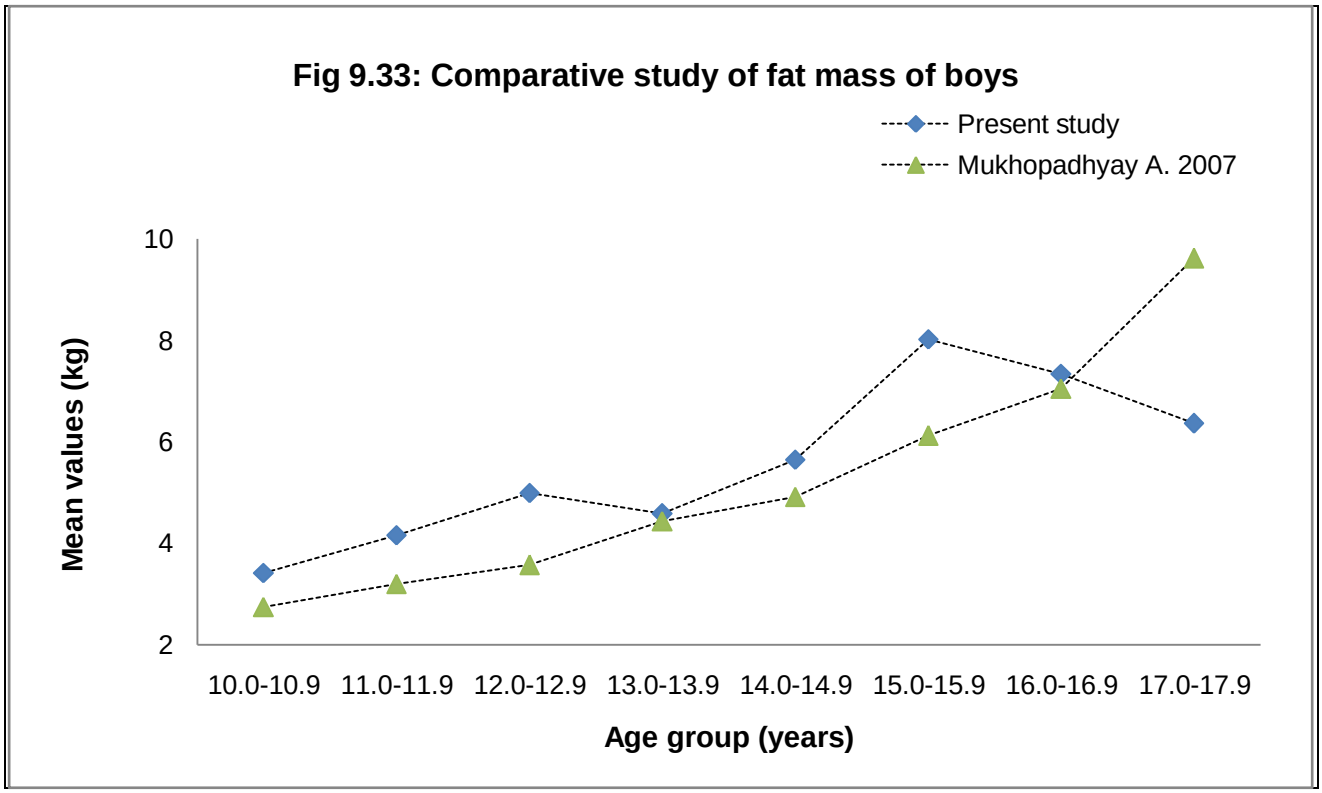
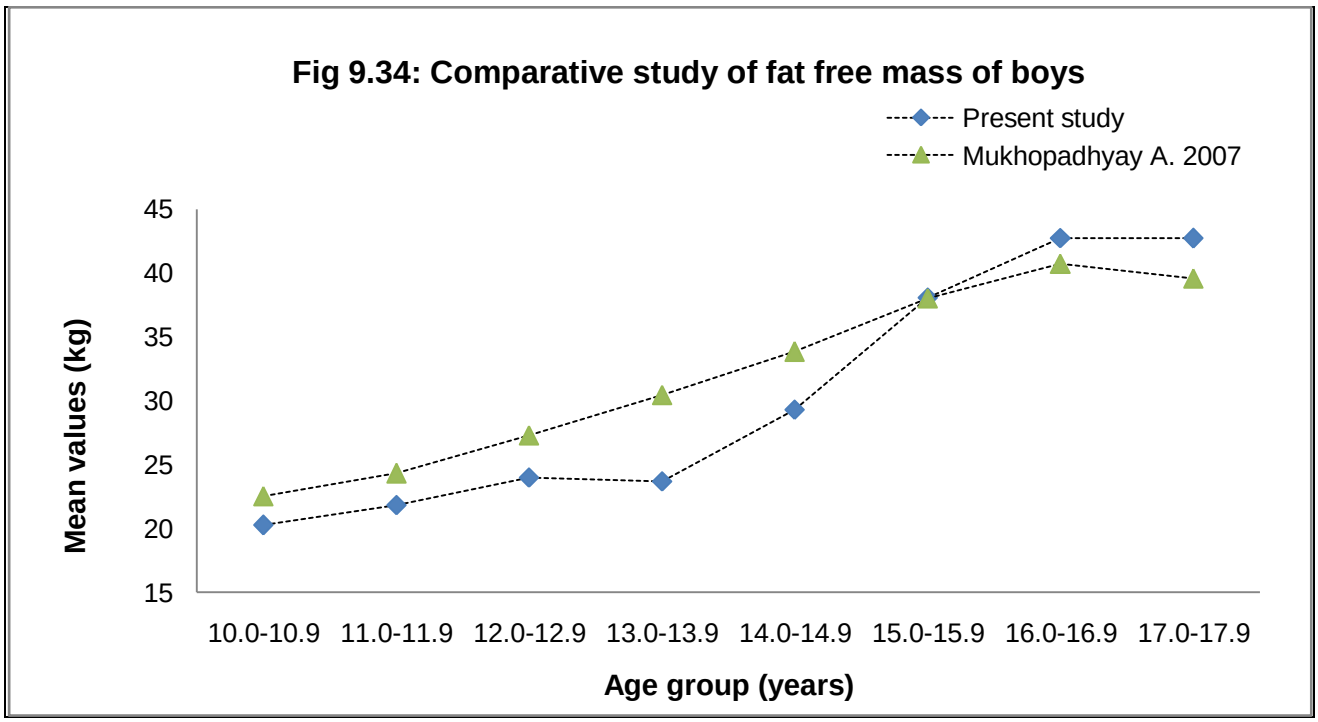


Fig 9.34: Comparative study of fat free mass of boys



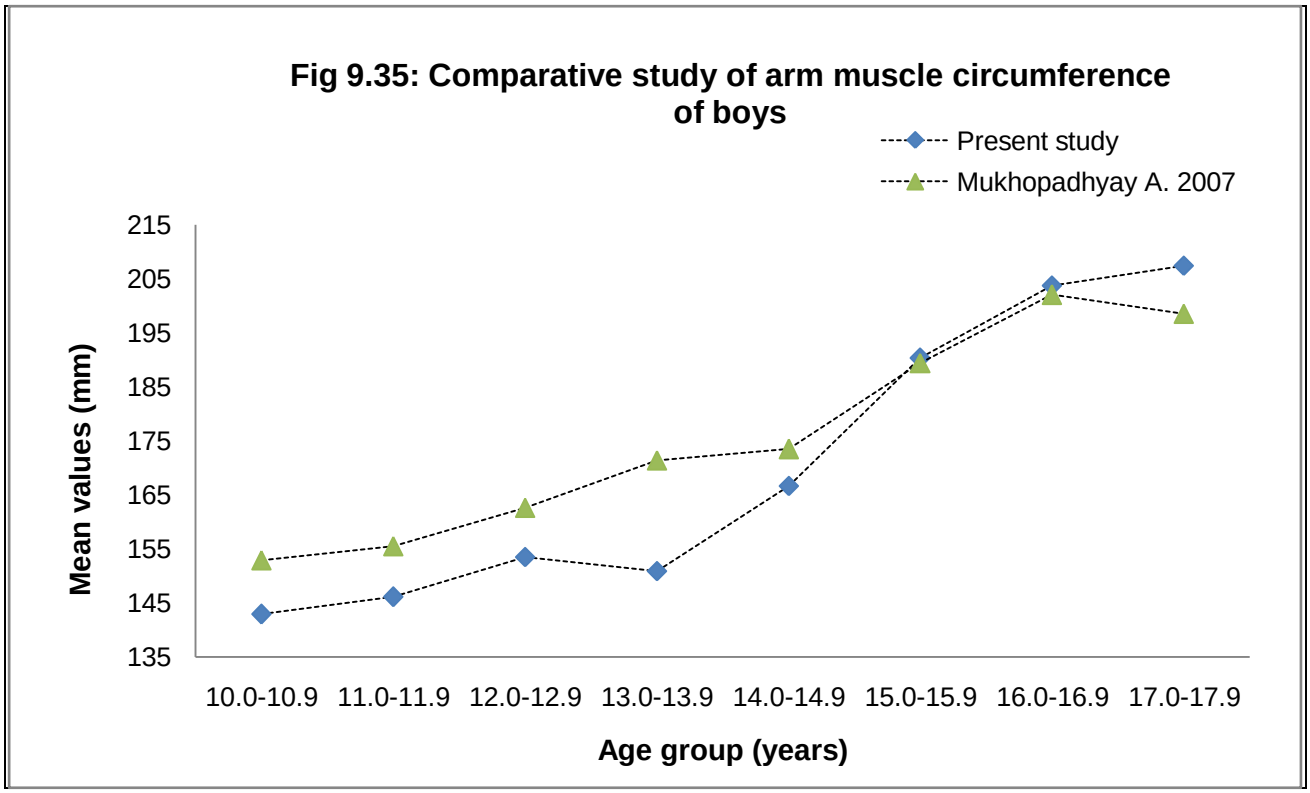


Fig 9.35: Comparative study of arm muscle circumference of boys

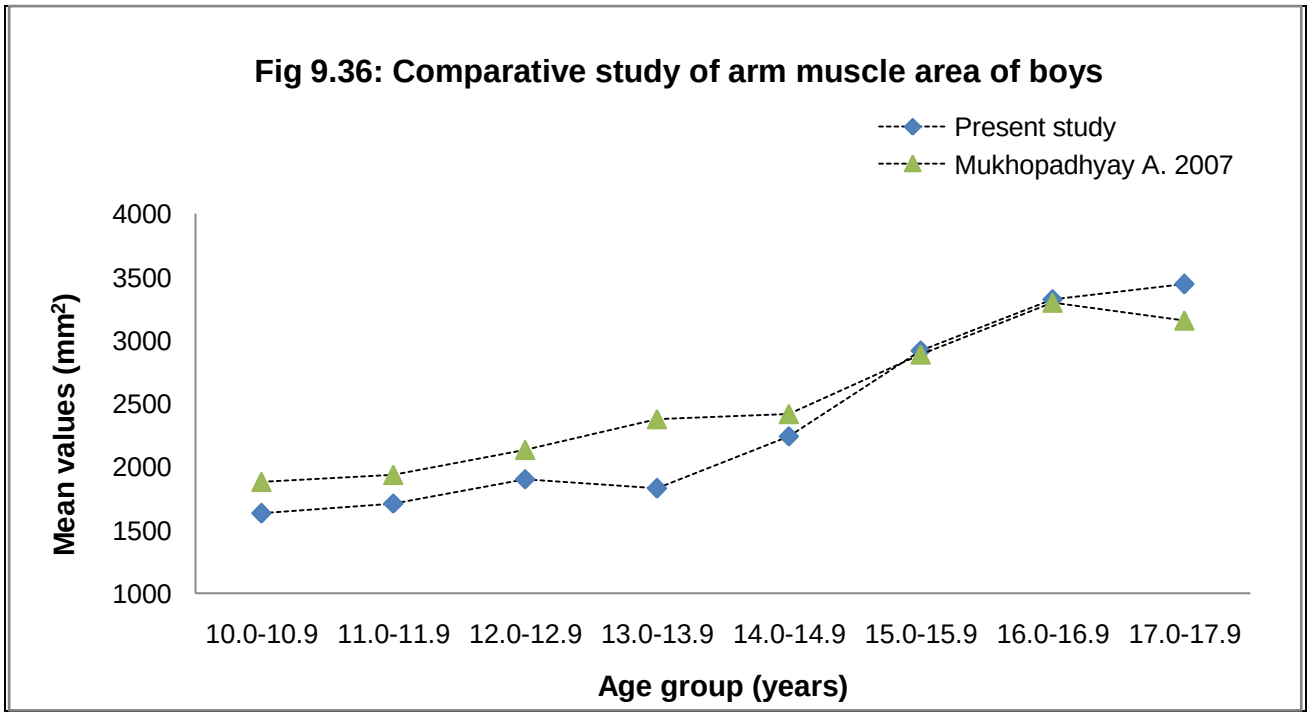


Fig 9.36: Comparative study of arm muscle area of boys

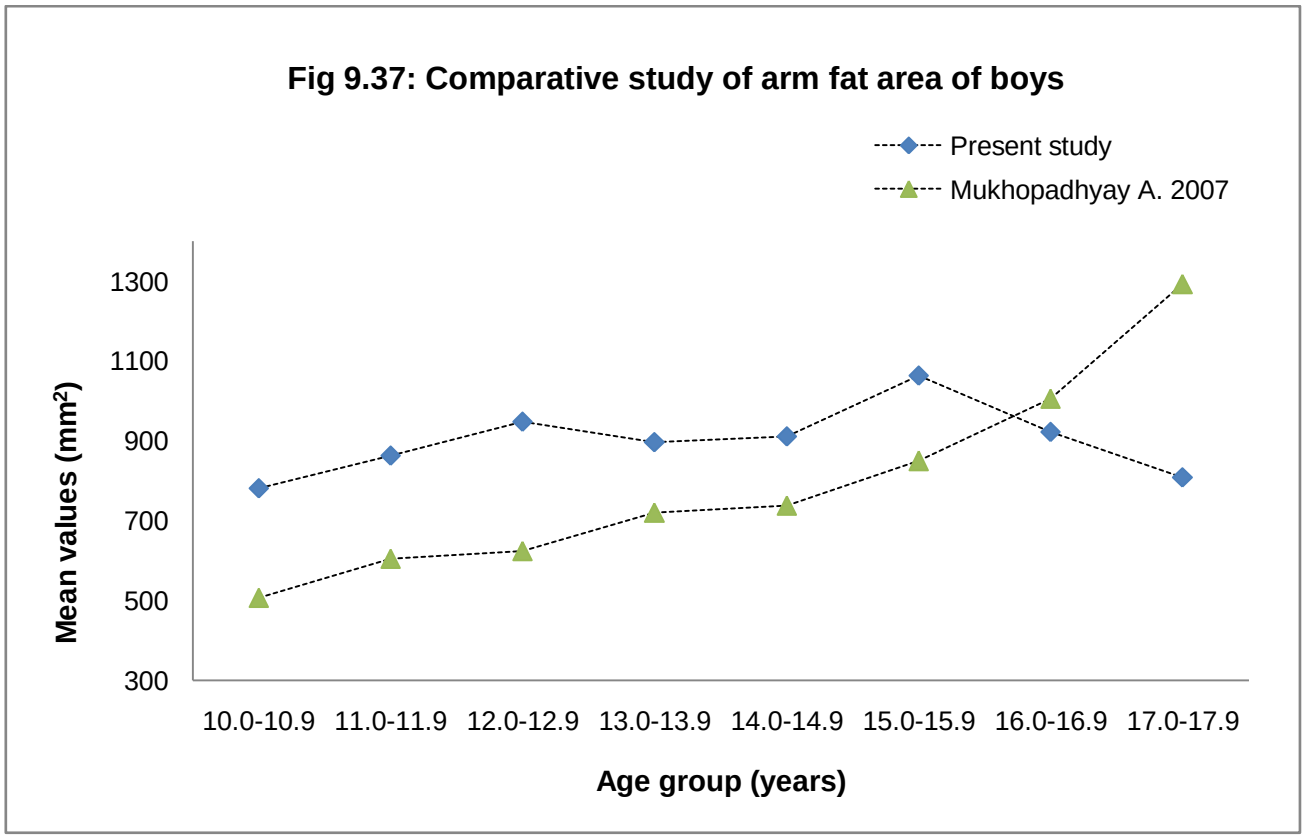


Fig 9.37: Comparative study of arm fat area of boys
Present study
Mukhopadhyay A. 2007
Mean values (mm²)
1300
1100
900
700
500
300
10.0-10.9
11.0-11.9
12.0-12.9
13.0-13.9
14.0-14.9
15.0-15.9
16.0-16.9
17.0-17.9
Age group (years)

9.3 NUTRITIONAL STATUS

Improved child health and survival are considered universal humanitarian goals. In this respect, understanding the nutritional status of children has far-reaching implications for the better development of future generations (WHO 1986). Nutritional assessment is an evaluation of the nutritional status of individuals or populations through body measurements and / or measurements of food and nutrient intake. According to World Health Organization, the ultimate intention of nutritional assessment is to improve human health (Beghin et al. 1988).

Adolescence is a period of rapid growth after childhood. Among adolescents the nutritional requirements increase because the growth rate increases. The monitoring of children's nutritional status is a fundamental tool for the evaluation of their health conditions and a unique opportunity for obtaining objectives measures for the health assessment of a population.

Malnutrition (undernutrition or overnutrition), is an impairment of health either from a deficiency or excess or imbalance of nutrients, is of public health significance among adolescents all over the world. It creates lasting effect on the growth and development of an individual. Malnutrition is a problem at varying proportions in developing countries including India, and anthropometry is a simple tool to assess its magnitude in children and adolescents. Measures obtained from anthropometry can be sensitive indicators of health and fitness in children and adolescents (WHO 1989).

Anthropometry has been productively used during adolescence in many contexts related to nutritional status because its use is inexpensive, non-invasive and suitable for large-scale population surveys (WHO 1995, Ulijaszek and Kerr 1999). It has now been well recognized worldwide that anthropometric measurements are indispensable in diagnosing undernutrition. Cohort studies, ideal for nutritional conditioning monitoring, suffer, in Third World countries, from the logistic difficulties usually associated with population studies of large magnitude. In such cases, cross-sectional studies can provide relevant elements for understanding the connection between health status and physical conditions of life. These studies have the advantage of relatively low costs, and they can

also provide fundamental information for the implementation of health surveillance systems and the definition of long-term health intervention strategies (WHO 1983, Satyanarayana et al. 1989).

Undernutrition continues to be a cause of ill-health and premature mortality among children in developing countries like India (Nandy et al. 2005). The most commonly used indicators of undernutrition are stunting (low height for age) and underweight (low weight for age). Stunting is an indicator of chronic undernutrition, the result of prolonged food deprivation and/or disease or illness; underweight is used as a composite indicator to reflect both acute and chronic undernutrition, although it cannot distinguish between them (WHO 1995). These indicators were universally used to evaluate the nutritional status for children and adolescents (WHO 1995, Pawloski 2002, Bener and Kamal 2005).

On the other hand, the body mass index is the most conventional variable for determining nutritional status among adolescents (Himes and Bouchard 1989, Must et al. 1991, Rolland-Cachera 1993, WHO 1995). Several recent studies (Kanade et al. 1999, Singh and Mishra 2001, Venkaiah et al. 2002) have investigated nutritional status of adolescents from different parts of India. However, there is very little information on the nutritional status of adolescent boys from West Bengal (de Onis et al. 2001, Woodruff and Duffield 2002, Bose and Mukhopadhyay 2004, Mukhopadhyay et al. 2005d). The present investigation unfolds the latest nutritional status and age variations in the rates of malnutrition among 10-17 year old Bengalee Muslim children.

In general, the overall rate of undernutrition is 41.67% **(*Table 9.35*)**. The frequency of undernutrition of boys (combining all ages) varies between 23.33% among 16 years old to 72.73% in the age group of 13 years. The rate of undernutrition of girls varies between 11.43% among 15 years old to 58.90% in the age group of 11 years. A distinctive age variation in the change of the rate of undernutrition is observes in both sexes. Boys demonstrate a steady increase in the rate of undernutrition in the age group from 10 to 13 years. Thereafter, the rate decreases from 14 to 16 years then increases in the age group of 17 years. Contrarily, among girls there is a substantial increase in the rate of undernutrition in the age group from 10 to 11 years follows by a distinctive decrease in the age group from 12 to 15 years. Thereafter, there is an increase in the age group of 16 years and a slight decrease in the age group of 17 years. This is indicative of the fact

that, during adolescent spurt, there is an imbalance between nutritional requirements and nutritional intake. It is during this period (i.e. during adolescent spurt) that there is a high demand for energy and essential nutrients. Thereafter, the prevalence of undernutrition decreases sharply at subsequent ages, probably because of reduction of nutritional imbalance.

It observes that the levels of present undernutrition (thinness) of both the sexes are notably higher almost all ages. This indicates that the nutrients being currently consumed by the studied samples are inadequate. It is therefore imperative that efforts should be made to increase the nutritional supplements to the adolescents. Good nutrition must be promoted to prevent malnutrition and early detection of undernutrition should be a major concern of health care personal with introduction of early intervention.

Undernutrition is documented universal public health problem contributed substantially to children's survival (Rahmathullah et al. 1990). Comparative scanning in the global milieu (***Table 9.36***) depicts that the extent of undernutrition of Bengalee Muslim adolescents is higher (41.67%) than those reported by two Nepalese study, i.e. 36% (Kurz, 1996) and 34% (Woodruff et al. 1999); and markedly higher than those observed among rural African adolescents reported by Kurz 1996 (23%). However, the rate of undernutrition of the present study is higher to those of urban Bengalee adolescents of kolkata (36.49%, Mukhopadhyay et al., 2000) but significantly lower than those reported by one Indian study (53%, Kurz 1996) and two Kenyan investigations, i.e. 61% (Cookson et al., 1998) and 57% (Woodruff et al., 1998).

Considering sex variation, the rate of undernutrition among adolescent boys of the present study (52.49%) is distinctively higher than the two recent Indian studies: one of urban boys of Kolkata (50.50%) studied by de Onis et al. (2001) and another of urban Bengalee boys of Kolkata (41.08%) studied by Mukhopadhyay et al., (2000) but lower than rural boys of nine provinces of India (67%) reported by Venkaiah et al. (2002). The same is remarkably lower than those of Kenyan refugees (75%) reported by International Rescue Committee (1997). On the other hand, the rate of undernutrition among adolescent girls of the present sample (31.32%) demonstrates a significantly higher rate of undernutrition compares to Bangladeshi girls (16%) studied by Ahmed et

al. (1998), and urban Bengalee girls of Kolkata (30.61%) studied by Mukhopadhyay et al. (2000) but lower than Kenyan refugee girls (55%) and rural Indian girls (40%) reported by IRC (1997) and Venkaiah et al. (2002) respectively.

Based on the present findings appropriate health promotion and intervention programmes can be formulated for the Bengalee Muslim adolescents. Finally, effective implementation of these programmes should result in the reduction in the prevalence of undernutrition and related health hazards. This would have health as well as economic benefit to the country since Indian population is passing through a nutritional transition and is expected to witness higher prevalence of adult non-communicable diseases. Thus, from the public health point of view, most importantly, immediate nutritional intervention programmes are needed for execution among this population.

Furthermore, there is an urgent need for further studies to ascertain the relationship of this high rate of undernutrition with morbidity and mortality among Bengalee Muslim children. Moreover, since undernutrition has several underlying causes (WHO 1995, Lee and Nieman 2003), future investigations should aim at identifying the likely cause(s) of high rates of undernutrition among Indian children. Lastly, endeavors should be made to study the consequences of the functional impairments commonly associated with low BMI in this ethnic group. Similar studies should also be undertaken among other ethnic groups in India.

In a country like India, having with huge ethnic wealth, the foremost saddle for initiation of health promotion policies is the lack of appropriate database. High prevalence of low birth weight, high morbidity and mortality in children and poor child health to be major nutritional concerns in India. Nutritional research in India has previously focused on the serious problem of undernutrition related to nutrient deficit and high rates of infection (Griffiths and Bentley 2001). In general, data are scarce on the nutritional status of various ethnic groups specifically tribal populations of India (Khongsdier 2002, 2005; Bose and Chakraborty 2005, Bose et al. 2006). It has been suggested (Bose and Chakraborty 2005, Bose et al. 2006) that here is urgent need to evaluate the nutritional status of various tribes of India. Additionally, to date, there are insufficient studies from India (Venkaiah et al. 2002, Mukhopadhyay et al. 2005d), which

have dealt with sex differences in the level of undernutrition among children and adolescents. Thus, future research is needed to investigate the extent of undernutrition among Indian adolescent boys and girls.

In conclusion, the present study recommends extensive large-scale ethnic-specific database on undernutrition and more area-specific policies for the development of nutritional intervention programmes for the children. After all child's health is the future reflection of the nation's development.

Table 9.35: Prevalence of undernutrition (based on < 5th percentile of BMI) of 10 –17 years old rural Bengalee Muslim adolescents

Age groups (years)	Normal		Undernourished		Overall Undernourished
	Boys No (%)	Girls No (%)	Boys No (%)	Girls No (%)	Boys + Girls No (%)
10.0-10.9	27 (48.21)	36 (58.06)	29 (51.79)	26 (41.94)	55 (46.61)
11.0-11.9	25 (39.68)	30 (41.10)	38 (60.32)	43 (58.90)	81 (59.56)
12.0-12.9	22 (33.85)	40 (48.78)	43 (66.15)	42 (51.22)	85 (57.82)
13.0-13.9	21 (27.27)	59 (74.68)	56 (72.73)	20 (25.32)	76 (48.72)
14.0-14.9	36 (42.86)	66 (84.62)	48 (57.14)	12 (15.38)	60 (37.04)
15.0-15.9	39 (54.93)	62 (88.57)	32 (45.07)	8 (11.43)	40 (28.37)
16.0-16.9	46 (76.67)	44 (80.00)	14 (23.33)	11 (20.00)	25 (21.74)
17.0-17.9	32 (69.57)	38 (80.85)	14 (30.43)	9 (19.15)	23 (24.73)
All ages	248 (47.51)	375 (68.68)	274 (52.49)	171 (31.32)	445 (41.67)

Table 9.36: Comparative frequency of undernutrition among adolescents of different countries

Reference study	Area / Population	Sex	Date of survey	Under-nourishment
Kurz, 1996	Bombay, India	Both	1992-93	53.00%
Kurz, 1996	Nepal	Both	1992-93	36.00%
Kurz, 1996	Benin, West Africa	Both	1992-93	23.00%
Cookson et al., 1998	Dadaab, Kenya	Both	1998	61.00%
Woodruff et al., 1998	Kakuma, Kenya	Both	1998	57.00%
Woodruff et al., 1999	Nepal	Both	1999	34.00%
Mukhopadhyay et al., 2000	Kolkata, India	Both	2000	36.49%
Present study	**Deganga, India**	**Both**	**2015**	**41.67%**
de Onis et al., 2001	India	Boys	1982-83	50.50%
Venkaiah et al., 2002	India	Boys	1996-97	67.00%
I R C, 1997	Kakuma, Kenya	Boys	1997	75.00%
Mukhopadhyay et al., 2000	Kolkata, India	Boys	2000	41.08%
Present study	**Deganga, India**	**Boys**	**2015**	**52.49%**
Venkaiah et al., 2002	India	Girls	1996-97	40.00%
I R C, 1997	Kakuma, Kenya	Girls	1997	55.00%
Ahmed et al., 1998	Dhaka, Bangladesh	Girls	1995	16.00%
Mukhopadhyay et al., 2000	Kolkata, India	Girls	2000	30.61%
Present study	**Deganga, India**	**Girls**	**2015**	**31.32%**

9.4 PHYSICAL ACTIVITY

Physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure. Physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths globally.

Regular moderate intensity physical activity- such as walking, cycling, or participating in sports- has significant benefits for health. For instance, it can reduce the risk of cardiovascular diseases, diabetis, colon and breast cancer, and depression. Moreover adequate levels of physical activity will decrease the risk of a hip or vertebral fracture and help control weight.

There have been numerous studies of physical activity for children and young people in India (Ghosh A. 2010, Swaminathan et al. 2012). It is well known that the athletically inclined are apt to have smaller PBF and FM than sedentary individuals (Benke & Wilmore 1974). It is a common observation that overweight people tend to be physically inactive (Baecke et al. 1983, Kromhout et al. 1988). Triosi et al. (1991) had shown that mean BMI and abdomen-hip ratio were significantly lower, even after controlling for age, among US-American men, who undertook regular physical exercise compared with those who did not. In a large epidemiological study conducted in Finland, Rissanen et al. (1991) demonstrated that the prevalence of obesity was inversely associated with physical activity. Phillippaerts et al. (1999) had observed that physical activity during work was inversely related to adiposity in young middle-aged Belgian men. Guo et al. (1999) had found that physical activity was associated with decreases in BMI, PBF and FM among US-American men. Mukhopadhyay et al. (2005) had observed that boys who did not undertake regular physical exercise (NPE) had a significantly greater mean body mass index (BMI), PBF, FM and FMI compared with those who undertook regular physical exercise (PE).

It is clear from the studies cited above that there is an inverse relationship, in developed countries also in India, between physical exercise and adiposity. There is scanty information on adiposity and body composition in relation with physical activity of adolescents of West Bengal, India. But best of my knowledge the present investigation is

first from West Bengal, India. Therefore, there is a need to develop a database of Muslim adolescents adiposity and body composition in relation with physical activity from different parts of the country.

The present samples are divided into two groups i.e. NPE (Who did not undertake regular physical exercise) and PE (Who undertook regular physical exercise). Overall distribution of anthropometric measures, adiposity and body composition based on NPE and PE of the studies children shows that the mean values of height, weight, MUAC, BMI, FM, FFM of NPE boys are lower than the PE boys but the mean values of skinfold measurements, subcutaneous adiposity, PBF, fat mass index (FMI) and sum of 5 skinfolds (S5S) of NPE boys are higher than the other. The mean values of all the anthropometric measurements, adiposity and body composition characteristics of NPE girls are higher than the PE girls. Differences between NPE and PE boys and girls of all the measurements are statistically significant at the 0.05 level.

Age-wise impact of physical activity on height of Muslim adolescents of present study (***Table 8.37***) reveals that the NPE boys have lower mean height than the PE boys in each age group except the age group of 14 years. Mean values of height of NPE girls are higher than PE girls in the age group 10 to 13 years but the mean values in the age group of 14 to 17 years PE girls are higher than the other. The mean differences of height between NPE boys and PE boys are statistically significant at the 0.05 level of 10 years age and 15 years age. The mean differences of height between NPE girls and PE girls are statistically significant at the 0.05 level of 13 years age and 17 years age.

Age-wise impact of physical activity on weight of Muslim adolescents of present study (***Table 9.38***) reveals that the NPE boys have lower mean weight than the PE boys in the age group of 10, 11, 13 and 15 to 17 years except the age group of 12 and 14 years. Mean values of weight of NPE girls are higher than PE girls in the age group of 11 to 14 years but the age group of 10 and 15 to 17 years PE girls are heavier than the other. The mean differences of weight between NPE boys and PE boys are statistically significant at the 0.05 level of 10 years age. The mean differences of weight between NPE girls and PE girls are statistically significant at the 0.05 level of 13 years age.

Age-wise impact of physical activity on MUAC of Muslim adolescents of present study (***Table 9.39***) reveals that the NPE boys have slightly higher mean MUAC than the

PE boys in the age group of 12, 14, 15 and 17 years but the mean values in the age group of 10, 11, 13 and 16 years PE boys are slightly higher than the other. The mean differences of MUAC between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of MUAC of NPE girls are slightly higher than PE girls in the age group of 11 to 14 years but the mean values in the age group of 10 and 15 to 17 years PE girls are slightly higher than the other. The mean differences of MUAC between NPE girls and PE girls are statistically significant at the 0.05 level of 17 years age.

Age-wise impact of physical activity on chest circumference of Muslim adolescents of present study (***Table 9.40***) reveals that the NPE boys have lower mean chest circumference than the PE boys in each age group except in the age group of 17 years. The mean differences of chest circumference between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 years. Mean values of chest circumference of NPE girls are higher than PE girls in the age group of 10 to 13 and 15 years but the mean values in the age group of 14, 16 and 17 years PE girls are higher than the other. The mean differences of chest circumference between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 11 and 13 years.

Age-wise impact of physical activity on minimum waist circumference of Muslim adolescents of present study (***Table 9.41***) reveals that the NPE boys have higher mean minimum waist circumference than the PE boys in the age group of 12, 14 and 15 years but the mean values in the age group of 10, 11, 13, 16 and 17 years PE boys are higher than the other. The mean differences of minimum waist circumference between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 years. Mean values of minimum waist circumference of NPE girls are higher than PE girls in the age group of 11 to 14 and 16 years but the mean values in the age group of 10, 15 and 17 years PE girls are higher than the other. The mean differences of minimum waist circumference between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on maximum hip circumference of Muslim adolescents of present study (***Table 9.42***) reveals that the NPE boys have slightly lower

mean maximum hip circumference than the PE boys in each age group except in the age group of 14 years. The mean differences of minimum waist circumference between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of maximum hip circumference of NPE girls are lower than PE girls in the age group of 10, 11, 15 and 17 years but the mean values in the age group of 12 to 14 and 16 years PE girls are lower than the other. The mean differences of maximum hip circumference between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on calf circumference of Muslim adolescents of present study (***Table 9.43***) reveals that the NPE boys have slightly lower mean calf circumference than the PE boys in each age group except in the age group of 11 years. The mean differences of calf circumference between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of calf circumference of NPE girls are higher than PE girls in the age group of 11 to 13 and 15 years but the mean values in the age group of 10, 14, 16 and 17 years PE girls are slightly higher than the other. The mean differences of calf circumference between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on biceps of Muslim adolescents of present study (***Table 9.44***) reveals that the NPE boys have higher mean biceps than the PE boys in the age group of 11, 13, 14, 15 and 17 years but the mean values in the age group of 10, 12 and 16 years PE boys are slightly higher than the other. The mean differences of biceps between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 15 years. Mean values of biceps of NPE girls are higher than PE girls in each age group except the age group of 16 and 17 years. The mean differences of biceps between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on triceps of Muslim adolescents of present study (***Table 9.45***) reveals that the NPE boys have higher mean triceps than the PE boys in the age group of 13 to 15 years but the mean values in the age group of 10 to 12, 16 and 17 years PE boys are higher than the other. The mean differences of triceps between NPE boys and PE boys are not statistically significant at the 0.05 level in each

age group. Mean values of triceps of NPE girls are higher than PE girls in the age group of 12, 13 and 17 years but the mean values in the age group of 10, 11 and 14 to 16 years PE girls are higher than the other. The mean differences of triceps between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 10 years.

Age-wise impact of physical activity on subscapular of Muslim adolescents of present study (***Table 9.46***) reveals that the NPE boys have higher mean subscapular than the PE boys in the age group of 12 and 14 to 16 years but the mean values in the age group of 10, 11, 13 and 17 years PE boys are higher than the other. The mean differences of subscapular between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of subscapular of NPE girls are higher than PE girls in the age group of 12, 13 and 16 years but the mean values in the age group of 10, 11, 14 and 15 to 17 years PE girls are slightly higher than the other. The mean differences of subscapular between NPE girls and PE girls are not statistically significant at the 0.05 level in each age group.

Age-wise impact of physical activity on suprailiac of Muslim adolescents of present study (***Table 9.47***) reveals that the NPE boys have higher mean suprailiac than the PE boys in the age group of 11, 12, 14, 15 and 17 years but the mean values in the age group of 10, 13 and 16 years PE boys are higher than the other. The mean differences of suprailiac between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of suprailiac of NPE girls are higher than PE girls in each age group except the age group of 17 years. The mean differences of suprailiac between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 11 and 13 years.

Age-wise impact of physical activity on calf skinfold of Muslim adolescents of present study (***Table 9.48***) reveals that the NPE boys have higher mean calf skinfold than the PE boys in the age group of 11, 14 and 15 years but the mean values in the age group of 10, 12, 13, 16 and 17 years PE boys are higher than the other. The mean differences of calf skinfold between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 and 15 years. Mean values of calf skinfold of NPE girls are higher than PE girls in the age group of 12 to 16 years but the mean values in the age group of 10, 11 and 17 years PE girls are higher than the other. The mean

differences of calf skinfold between NPE girls and PE girls are not statistically significant at the 0.05 level in each age group.

Age-wise impact of physical activity on BMI of Muslim adolescents of present study (***Table 9.49***) reveals that the NPE boys have higher mean BMI than the PE boys in each age group. The mean differences of BMI between NPE boys and PE boys are statistically significant at the 0.05 level in each age group. Mean values of BMI of NPE girls are higher than PE girls in the age group of 11 to 16 years but the mean values in the age group of 10 and 17 years PE girls are slightly higher than the other. The mean differences of BMI between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on CI of Muslim adolescents of present study (***Table 9.50***) reveals that the NPE boys have higher mean CI than the PE boys in the age group of 12, 14 and 15 years but the mean values in the age group of 10,11,13,16 and 17 years PE boys are higher than the other. The mean differences of CI between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 15 years. Mean values of CI of NPE girls are higher than PE girls in the age group of 10, 14 and 16 years but the mean values in the age group of 12, 13 and 17 years PE girls are higher than the other. The mean differences of CI between NPE girls and PE girls are not statistically significant at the 0.05 level.

Age-wise impact of physical activity on WHR of Muslim adolescents of present study (***Table 9.51***) reveals that the NPE boys have higher mean WHR than the PE boys in the age group of 12, 15 and 16 years but the mean values in the age group of 11, 13 and 17 years PE boys are higher than the other. The mean differences of WHR between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 15 years. Mean values of WHR of NPE girls are higher than PE girls in the age group of 10 to 12, 15 and 16 years but the mean values in the age group of 13 and 17 years PE girls are higher than the other. The mean differences of WHR between NPE girls and PE girls are not statistically significant at the 0.05 level.

Age-wise impact of physical activity on WHTR of Muslim adolescents of present study (***Table 9.52***) reveals that the NPE boys have higher mean WHTR than the PE boys in the age group of 12, 14 and 15 years but the mean values in the age group of

11, 13 and 16 years PE boys are higher than the other. The mean differences of WHTR between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 15 years. Mean values of WHTR of NPE girls are higher than PE girls in the age group of 13 and 16 years. The mean differences of WHTR between NPE girls and PE girls are not statistically significant at the 0.05 level.

Age-wise impact of physical activity on STR of Muslim adolescents of present study (***Table 9.53***) reveals that the NPE boys have higher mean STR than the PE boys in the age group of 10 to 12, 16 and 17 years but the mean values in the age group of 13 and 14 years PE boys are slightly higher than the other. The mean differences of STR between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of STR of NPE girls are higher than PE girls in each age group except the age group of 12 and 17 years. The mean differences of STR between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 16 years.

Age-wise impact of physical activity on TEFR of Muslim adolescents of present study (***Table 9.54***) reveals that the NPE boys have higher mean TEFR than the PE boys in the age group of 10, 12 and 16 years and the mean values in the age group of 13, 14 and 15 years PE boys are higher than the other but the mean values in the age group of 11 and 17 years of NPE and PE boys are equal. The mean differences of TEFR between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of TEFR of NPE girls are higher than PE girls in each age group except the age group of 17 years but the mean values in the age group of 14 years of NPE and PE girls are equal. The mean differences of TEFR between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 11 years.

Age-wise impact of physical activity on CPFR of Muslim adolescents of present study (***Table 9.55***) reveals that the NPE boys have higher mean CPFR than the PE boys in the age group of 10 to 12, 16 and 17 years but the mean values in the age group of 13, 14 and 15 years PE boys are slightly higher than the other. The mean differences of CPFR between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 16 years. Mean values of CPFR of NPE girls are higher than PE girls in each age group except the age group of 12 and 17 years. The mean differences of

CPFR between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 16 years.

Age-wise impact of physical activity on S5S of Muslim adolescents of present study (***Table 9.56***) reveals that the NPE boys have higher mean S5S than the PE boys in the age group of 11 and 13 to 15 years but the mean values in the age group of 10, 12, 16 and 17 years PE boys are higher than the other. The mean differences of S5S between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of S5S of NPE girls are higher than PE girls in the age group of 11 to 14 and 16 years but the mean values in the age group of 10, 15 and 17 years PE boys are higher than the other. The mean differences of S5S between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on STS of Muslim adolescents of present study (***Table 9.57***) reveals that the NPE boys have higher mean STS than the PE boys in the age group of 11, 12, 14 and 15 years but the mean values in the age group of 10, 13, 16 and 17 years PE boys are slightly higher than the other. The mean differences of STS between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of STS of NPE girls are higher than PE girls in the age group of 10 to 14 and 16 years but the mean values in the age group of 15 and 17 years PE boys are higher than the other. The mean differences of STS between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on SES of Muslim adolescents of present study (***Table 9.58***) reveals that the NPE boys have higher mean SES than the PE boys in the age group of 11, 13, 14 and 15 years but the mean values in the age group of 10, 12, 16 and 17 years PE boys are higher than the other. The mean differences of SES between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 and 15 years. Mean values of SES of NPE girls are higher than PE girls in the age group of 12 to 14 years but the mean values in the age group of 10, 11 and 15 to 17 years PE boys are higher than the other. The mean differences of SES between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on PBF of Muslim adolescents of present study (***Table 9.59***) reveals that the NPE boys have higher mean PBF than the PE boys

in the age group of 11 and 13 to 15 years but the mean values in the age group of 10, 12, 16 and 17 years PE boys are higher than the other. The mean differences of PBF between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 and 15 years. Mean values of PBF of NPE girls are higher than PE girls in the age group of 12 and 13 years but the mean values in the age group of 10, 11 and 14 to 17 years PE boys are higher than the other. The mean differences of PBF between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on FM of Muslim adolescents of present study (***Table 9.60***) reveals that the NPE boys have higher mean FM than the PE boys in the age group of 11, 12 and 14 to 16 years but the mean values in the age group of 10, 13 and 17 years PE boys are higher than the other. The mean differences of FM between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 years. Mean values of FM of NPE girls are higher than PE girls in the age group of 12 to 14 years but the mean values in the age group of 10, 11 and 15 to 17 years PE boys are higher than the other. The mean differences of FM between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on FFM of Muslim adolescents of present study (***Table 9.61***) reveals that the NPE boys have lower mean FFM than the PE boys in each age group except the age group of 17 years. The mean differences of FFM between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 years. Mean values of FFM of NPE girls are higher than PE girls in the age group of 11 to 15 years but the mean values in the age group of 10, 16 and 17 years PE girls are higher than the other. The mean differences of FFM between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on FMI of Muslim adolescents of present study (***Table 9.62***) reveals that the NPE boys have higher mean FMI than the PE boys in the age group of 11, 12, 14 and 15 years but the mean values in the age group of 10, 13, 16 and 17 years PE boys are higher than other. The mean differences of FMI between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 years. Mean values of FMI of NPE girls are lower than PE girls in each age group except

the age group of 12 to 14 years. The mean differences of FMI between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on FFMI of Muslim adolescents of present study (***Table 9.63***) reveals that the NPE boys have higher mean FFMI than the PE boys in each age group except the age group of 11, 13 and 14 years. The mean differences of FFMI between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of FFMI of NPE girls are higher than PE girls in each age group except the age group of 10 years. The mean differences of FFMI between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 13 years.

Age-wise impact of physical activity on AMC and AMA of Muslim adolescents of present study (***Table 9.64 and Table 9.65***) reveals that the NPE boys have lower mean AMC and AMA than the PE boys in each age group except the age group of 12 and 17 years. The mean differences of AMC and AMA between NPE boys and PE boys are not statistically significant at the 0.05 level in each age group. Mean values of AMC and AMA of NPE girls are higher than PE girls in each age group except the age group of 10 and 17 years. The mean differences of AMC and AMA between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 11 years.

Age-wise impact of physical activity on AFA of Muslim adolescents of present study (***Table 9.66)*** reveals that the NPE boys have higher mean AFA than the PE boys in the age group of 12 and 14 to 16 years but the mean values in the age group of 10, 11, 13 and 17 years PE boys are higher than the other. The mean differences of AFA between NPE boys and PE boys are statistically significant at the 0.05 level in the age group of 10 years. Mean values of AFA of NPE girls are lower than PE girls in each age group except the age group of 11 to 13 years. The mean differences of AFA between NPE girls and PE girls are statistically significant at the 0.05 level in the age group of 10 years.

It clearly demonstrates that boys (who practiced physical exercise) are taller and heavier than the findings of Mukhopadhyay et al. 2005. Boys who are not practiced physical exercise are shorter and lower than the boys (Mukhopadhyay et al. 2005).

At the end, it is clear that there is a close relationship between adiposity and body composition with physical activity. There is a decrease in adiposity, subcutaneous fat content and body composition almost all ages of PE boys and girls compared with the children who did not practiced regular physical exercise resulting from non sedentary lifestyle. This kind of study is most essential, to understand the effect of physical activity on fat content of children from India. However, till date such efforts are lacking from west Bengal as well as India.

Table 9.37: Impact of physical activity on height (cm) of adolescents of present study

Age groups	Height (cm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	3.65*	n= 16	n= 46	0.03
	124.93 (4.15)	**129.17** (4.31)		**127.73** (3.49)	**127.70** (4.94)	
11.0-11.9	n= 31	n= 32	0.84	n= 22	n= 51	0.61
	130.90 (6.36)	**132.18** (5.67)		**133.84** (5.06)	**133.03** (5.49)	
12.0-12.9	n= 35	n= 30	1.02	n= 21	n= 61	0.45
	135.11 (6.67)	**136.53** (4.47)		**141.51** (6.93)	**140.76** (5.75)	
13.0-13.9	n= 44	n= 33	0.92	n= 33	n= 46	3.24*
	135.52 (6.24)	**136.85** (6.39)		**149.65** (5.27)	**144.75** (8.14)	
14.0-14.9	n= 50	n= 34	0.03	n= 32	n= 46	0.12
	145.85 (10.69)	**145.79** (8.78)		**149.36** (6.15)	**149.52** (5.66)	
15.0-15.9	n= 44	n= 27	2.51*	n= 48	n= 22	1.00
	155.85 (12.53)	**161.66** (6.91)		**150.10** (5.28)	**151.56** (5.82)	
16.0-16.9	n= 12	n= 48	0.53	n= 41	n= 14	0.36
	163.83 (6.16)	**164.88** (5.97)		**152.59** (4.80)	**153.12** (4.78)	
17.0-17.9	n= 03	n= 43	0.96	n= 29	n= 18	2.16*
	159.53 (7.60)	**163.79** (4.89)		**150.46** (6.24)	**154.02** (4.95)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.38: Impact of physical activity on weight (kg) of adolescents of present study

Age groups	Weight (kg)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	3.07*	n= 16	n= 46	0.96
	22.50 (2.01)	**24.36** (2.47)		**23.31** (2.86)	**24.11** (2.90)	
11.0-11.9	n= 31	n= 32	0.31	n= 22	n= 51	0.53
	25.84 (4.63)	**26.17** (3.94)		**26.80** (4.88)	**26.14** (4.93)	
12.0-12.9	n= 35	n= 30	0.09	n= 21	n= 61	1.13
	29.06 (9.63)	**28.88** (5.65)		**32.10** (7.85)	**30.01** (5.48)	
13.0-13.9	n= 44	n= 33	0.83	n= 33	n= 46	3.54*
	27.85 (4.74)	**28.85** (5.58)		**40.08** (6.21)	**34.96** (6.51)	
14.0-14.9	n= 50	n= 34	0.16	n= 32	n= 46	0.35
	35.05 (8.85)	**34.79** (6.27)		**39.91** (7.40)	**39.37** (5.36)	
15.0-15.9	n= 44	n= 27	0.60	n= 48	n= 22	0.24
	45.52 (11.61)	**47.03** (9.36)		**43.13** (8.13)	**43.59** (7.48)	
16.0-16.9	n= 12	n= 48	0.69	n= 41	n= 14	0.14
	49.04 (5.45)	**50.35** (7.36)		**42.57** (5.43)	**42.86** (7.17)	
17.0-17.9	n= 03	n= 43	0.47	n= 29	n= 18	1.07
	48.33 (2.47)	**49.11** (5.63)		**42.48** (5.16)	**44.64** (7.57)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.39: Impact of physical activity on MUAC (cm) of adolescents of present study

Age groups	MUAC (cm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	1.60	n= 16	n= 46	1.73
	16.79 (0.76)	**17.23** (1.34)		**17.02** (1.22)	**17.65** (1.38)	
11.0-11.9	n= 31	n= 32	0.69	n= 22	n= 51	1.44
	17.38 (1.86)	**17.69** (1.76)		**18.55** (2.36)	**17.73** (1.95)	
12.0-12.9	n= 35	n= 30	0.14	n= 21	n= 61	0.92
	18.40 (3.33)	**18.30** (2.18)		**19.29** (2.93)	**16.66** (1.93)	
13.0-13.9	n= 44	n= 33	0.94	n= 33	n= 46	1.94
	17.86 (1.79)	**18.31** (2.24)		**21.11** (2.03)	**20.17** (2.25)	
14.0-14.9	n= 50	n= 34	0.10	n= 32	n= 46	0.08
	19.51 (2.47)	**19.46** (1.85)		**21.52** (3.02)	**21.47** (2.02)	
15.0-15.9	n= 44	n= 27	0.37	n= 48	n= 22	0.54
	21.98 (3.17)	**21.73** (2.50)		**22.06** (2.83)	**22.42** (2.41)	
16.0-16.9	n= 12	n= 48	0.99	n= 41	n= 14	0.17
	22.38 (1.46)	**22.91** (2.33)		**21.47** (2.22)	**21.61** (2.75)	
17.0-17.9	n= 03	n= 43	0.23	n= 29	n= 18	0.51*
	23.07 (1.17)	**22.90** (1.85)		**21.98** (1.74)	**22.33** (2.57)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.40: Impact of physical activity on chest (cm) of adolescents of present study

Age groups	Chest (cm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.17*	n= 16	n= 46	0.25
	60.35 (3.79)	**62.55** (3.47)		**63.08** (5.35)	**62.72** (3.32)	
11.0-11.9	n= 31	n= 32	0.69	n= 22	n= 51	2.35*
	63.78 (5.37)	**64.69** (5.15)		**67.67** (5.92)	**64.09** (6.09)	
12.0-12.9	n= 35	n= 30	0.07	n= 21	n= 61	0.64
	65.98 (9.22)	**66.12** (6.18)		**68.95** (7.33)	**67.83** (5.35)	
13.0-13.9	n= 44	n= 33	0.85	n= 33	n= 46	3.24*
	65.00 (5.53)	**66.01** (4.90)		**75.65** (5.99)	**71.41** (5.36)	
14.0-14.9	n= 50	n= 34	0.49	n= 32	n= 46	0.04
	70.10 (7.31)	**70.85** (6.59)		**75.36** (5.57)	**75.41** (4.25)	
15.0-15.9	n= 44	n= 27	1.01	n= 48	n= 22	0.65
	78.12 (8.79)	**80.16** (7.87)		**79.16** (6.33)	**78.21** (5.32)	
16.0-16.9	n= 12	n= 48	1.22	n= 41	n= 14	0.24
	81.14 (3.93)	**82.86** (5.79)		**77.84** (5.60)	**78.27** (5.83)	
17.0-17.9	n= 03	n= 43	0.29	n= 29	n= 18	0.26
	83.00 (1.99)	**82.60** (5.11)		**78.83** (3.74)	**79.19** (5.13)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.41: Impact of physical activity on minimum waist (cm) of adolescents of present study

Age groups	Minimum waist (cm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.22*	n= 16	n= 46	0.08
	54.66 (2.24)	**56.21** (2.94)		**56.81** (4.11)	**58.90** (3.93)	
11.0-11.9	n= 31	n= 32	1.08	n= 22	n= 51	0.31
	56.40 (6.45)	**58.09** (6.00)		**57.98** (6.14)	**57.51** (5.65)	
12.0-12.9	n= 35	n= 30	0.23	n= 21	n= 61	0.46
	59.08 (10.52)	**58.61** (5.97)		**59.71** (6.41)	**58.97** (6.11)	
13.0-13.9	n= 44	n= 33	1.68	n= 33	n= 46	2.34*
	57.22 (4.83)	**59.25** (5.54)		**64.18** (6.86)	**60.90** (4.94)	
14.0-14.9	n= 50	n= 34	0.33	n= 32	n= 46	0.55
	62.19 (6.62)	**61.76** (5.15)		**63.37** (7.08)	**62.57** (5.01)	
15.0-15.9	n= 44	n= 27	0.99	n= 48	n= 22	0.23
	68.07 (9.16)	**66.03** (8.02)		**65.12** (7.61)	**65.58** (7.88)	
16.0-16.9	n= 12	n= 48	0.79	n= 41	n= 14	0.34
	67.54 (4.48)	**68.79** (6.11)		**64.03** (6.34)	**63.25** (7.66)	
17.0-17.9	n= 03	n= 43	0.73	n= 29	n= 18	0.86
	64.67 (5.13)	**66.91** (4.80)		**64.84** (6.23)	**66.71** (7.78)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.42: Impact of physical activity on maximum hip (cm) of adolescents of present study

Age groups	Maximum hip (cm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	1.60	n= 16	n= 46	1.10
	61.92 (3.97)	**63.53** (3.05)		**62.84** (3.22)	**63.97** (4.28)	
11.0-11.9	n= 31	n= 32	0.79	n= 22	n= 51	0.23
	63.67 (5.03)	**64.65** (4.85)		**65.75** (8.04)	**66.17** (5.04)	
12.0-12.9	n= 35	n= 30	0.40	n= 21	n= 61	0.39
	66.97 (8.69)	**67.68** (5.35)		**70.62** (8.82)	**69.83** (5.65)	
13.0-13.9	n= 44	n= 33	1.09	n= 33	n= 46	3.35*
	65.92 (4.54)	**67.08** (4.61)		**78.81** (6.23)	**73.87** (6.77)	
14.0-14.9	n= 50	n= 34	0.31	n= 32	n= 46	0.58
	72.14 (7.09)	**71.72** (5.51)		**78.74** (6.39)	**77.93** (5.70)	
15.0-15.9	n= 44	n= 27	0.36	n= 48	n= 22	0.10
	80.12 (8.11)	**80.74** (6.66)		**80.03** (6.48)	**81.54** (5.57)	
16.0-16.9	n= 12	n= 48	1.66	n= 41	n= 14	0.72
	81.28 (3.96)	**83.53** (5.00)		**80.67** (6.50)	**79.36** (5.69)	
17.0-17.9	n= 03	n= 43	0.55	n= 29	n= 18	0.80
	81.73 (2.73)	**82.67** (3.98)		**80.47** (5.74)	**81.99** (6.67)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.43: Impact of physical activity on calf circumference (cm) of adolescents of present study

Age groups	Calf circumference (cm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21 **23.32** (1.31)	n= 35 **24.61** (5.61)	1.30	n= 16 **23.43** (1.30)	n= 46 **24.01** (1.77)	1.40
11.0-11.9	n= 31 **24.53** (3.00)	n= 32 **24.52** (1.65)	0.01	n= 22 **24.95** (2.42)	n= 51 **24.29** (2.14)	1.11
12.0-12.9	n= 35 **25.02** (3.10)	n= 30 **25.49** (2.31)	0.71	n= 21 **26.71** (3.48)	n= 61 **25.59** (2.23)	1.38
13.0-13.9	n= 44 **24.87** (2.01)	n= 33 **25.52** (2.30)	1.30	n= 33 **28.86** (2.31)	n= 46 **27.25** (2.37)	3.01*
14.0-14.9	n= 50 **27.22** (2.97)	n= 34 **28.34** (6.33)	0.96	n= 32 **28.58** (2.68)	n= 46 **28.85** (2.11)	0.48
15.0-15.9	n= 44 **29.78** (4.26)	n= 27 **30.46** (2.70)	0.82	n= 48 **29.56** (2.46)	n= 22 **29.03** (2.70)	0.79
16.0-16.9	n= 12 **30.62** (1.59)	n= 48 **31.52** (2.30)	1.60	n= 41 **28.94** (2.50)	n= 14 **29.26** (2.37)	0.44
17.0-17.9	n= 03 **30.50** (0.46)	n= 43 **30.83** (3.14)	0.60	n= 29 **29.20** (1.98)	n= 18 **30.07** (3.12)	1.07

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.44: Impact of physical activity on biceps (mm) of adolescents of present study

Age groups	Biceps (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	1.44	n= 16	n= 46	0.04
	4.53 (1.08)	**4.99** (1.24)		**6.05** (1.91)	**6.03** (1.84)	
11.0-11.9	n= 31	n= 32	0.60	n= 22	n= 51	1.25
	5.84 (2.84)	**5.41** (2.78)		**7.34** (2.87)	**6.43** (2.82)	
12.0-12.9	n= 35	n= 30	0.23	n= 21	n= 61	1.36
	6.19 (3.86)	**6.37** (2.72)		**7.39** (2.64)	**6.48** (2.65)	
13.0-13.9	n= 44	n= 33	0.50	n= 33	n= 46	2.03*
	5.84 (2.35)	**5.58** (2.19)		**8.88** (2.69)	**7.74** (2.11)	
14.0-14.9	n= 50	n= 34	1.31	n= 32	n= 46	1.33
	6.01 (2.37)	**5.36** (2.16)		**8.79** (3.05)	**7.92** (2.52)	
15.0-15.9	n= 44	n= 27	2.30*	n= 48	n= 22	0.63
	6.75 (4.03)	**5.10** (1.99)		**9.55** (3.35)	**9.05** (3.02)	
16.0-16.9	n= 12	n= 48	1.14	n= 41	n= 14	0.44
	4.47 (1.35)	**5.01** (1.92)		**8.28** (2.70)	**8.79** (3.97)	
17.0-17.9	n= 03	n= 43	1.10	n= 29	n= 18	1.20
	6.00 (2.31)	**4.52** (1.00)		**9.01** (2.62)	**10.12** (3.32)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.45: Impact of physical activity on triceps (mm) of adolescents of present study

Age groups	Triceps (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	1.90	n= 16	n= 46	2.17*
	8.21 (1.63)	**9.21** (2.31)		**9.69** (2.57)	**11.34** (2.79)	
11.0-11.9	n= 31	n= 32	0.88	n= 22	n= 51	0.43
	8.99 (3.01)	**9.66** (3.05)		**10.85** (4.04)	**11.27** (3.23)	
12.0-12.9	n= 35	n= 30	0.12	n= 21	n= 61	0.33
	9.51 (4.14)	**9.62** (3.08)		**11.67** (3.96)	**11.34** (3.87)	
13.0-13.9	n= 44	n= 33	0.27	n= 33	n= 46	1.48
	9.51 (2.98)	**9.33** (2.94)		**13.61** (3.58)	**12.51** (2.76)	
14.0-14.9	n= 50	n= 34	0.81	n= 32	n= 46	1.21
	9.19 (2.85)	**8.69** (2.79)		**12.86** (3.51)	**13.90** (3.96)	
15.0-15.9	n= 44	n= 27	1.81	n= 48	n= 22	1.33
	9.76 (4.95)	**8.04** (3.11)		**14.15** (4.31)	**15.64** (4.37)	
16.0-16.9	n= 12	n= 48	1.35	n= 41	n= 14	0.56
	6.90 (1.92)	**7.93** (3.61)		**13.93** (3.66)	**14.64** (4.27)	
17.0-17.9	n= 03	n= 43	1.08	n= 29	n= 18	0.08
	5.80 (1.83)	**6.97** (1.66)		**13.85** (3.19)	**13.74** (4.79)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.46: Impact of physical activity on subscapular (mm) of adolescents of present study

Age groups	Subscapular (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	1.17	n= 16	n= 46	0.51
	5.57 (1.24)	**6.02** (1.63)		**7.76** (2.47)	**8.13** (2.40)	
11.0-11.9	n= 31	n= 32	0.39	n= 22	n= 51	0.04
	6.81 (3.21)	**7.18** (4.33)		**8.85** (4.35)	**8.90** (4.18)	
12.0-12.9	n= 35	n= 30	0.24	n= 21	n= 61	0.20
	7.28 (4.46)	**7.05** (3.40)		**9.21** (4.45)	**8.99** (4.32)	
13.0-13.9	n= 44	n= 33	0.18	n= 33	n= 46	1.72
	6.66 (2.30)	**6.79** (3.68)		**12.81** (5.11)	**11.04** (3.48)	
14.0-14.9	n= 50	n= 34	0.42	n= 32	n= 46	0.16
	7.35 (2.45)	**7.11** (2.59)		**12.49** (4.58)	**12.67** (4.55)	
15.0-15.9	n= 44	n= 27	1.28	n= 48	n= 22	0.21
	10.44 (5.10)	**9.02** (4.10)		**15.26** (5.74)	**15.57** (5.96)	
16.0-16.9	n= 12	n= 48	0.09	n= 41	n= 14	0.60
	9.38 (2.71)	**9.30** (3.37)		**13.55** (4.26)	**12.70** (4.61)	
17.0-17.9	n= 03	n= 43	0.16	n= 29	n= 18	1.40
	9.00 (3.30)	**9.32** (2.12)		**13.59** (4.45)	**15.52** (4.70)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.47: Impact of physical activity on suprailiac (mm) of adolescents of present study

Age groups	Suprailiac (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	0.36	n= 16	n= 46	0.42
	5.52 (1.22)	**5.66** (1.63)		**8.56** (3.71)	**8.14** (2.51)	
11.0-11.9	n= 31	n= 32	0.54	n= 22	n= 51	2.39*
	7.57 (4.41)	**6.99** (4.23)		**10.24** (4.68)	**7.53** (3.84)	
12.0-12.9	n= 35	n= 30	0.20	n= 21	n= 61	1.78
	8.07 (5.68)	**7.82** (4.41)		**10.23** (4.66)	**8.23** (3.67)	
13.0-13.9	n= 44	n= 33	0.05	n= 33	n= 46	2.41*
	7.01 (3.55)	**7.05** (2.96)		**13.12** (4.57)	**10.85** (3.40)	
14.0-14.9	n= 50	n= 34	0.31	n= 32	n= 46	1.31
	8.47 (4.00)	**8.18** (4.31)		**13.73** (4.65)	**12.47** (3.30)	
15.0-15.9	n= 44	n= 27	1.07	n= 48	n= 22	0.13
	10.95 (5.76)	**9.56** (5.10)		**14.77** (5.47)	**14.60** (5.19)	
16.0-16.9	n= 12	n= 48	0.19	n= 41	n= 14	0.67
	9.02 (3.65)	**9.25** (4.00)		**13.69** (3.95)	**12.84** (4.12)	
17.0-17.9	n= 03	n= 43	0.03	n= 29	n= 18	1.73
	8.60 (2.95)	**8.54** (2.90)		**12.81** (3.54)	**14.80** (4.01)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.48: Impact of physical activity on medial calf skinfold (mm) of adolescents of present study

Age groups	CSF (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.54*	n= 16	n= 46	1.38
	8.27 (1.93)	**9.74** (2.37)		**9.98** (2.31)	**10.93** (2.52)	
11.0-11.9	n= 31	n= 32	1.44	n= 22	n= 51	0.57
	10.88 (3.62)	**9.74** (2.54)		**11.25** (3.88)	**11.79** (3.17)	
12.0-12.9	n= 35	n= 30	0.73	n= 21	n= 61	1.02
	10.57 (3.92)	**11.20** (2.96)		**12.32** (3.72)	**11.42** (2.78)	
13.0-13.9	n= 44	n= 33	0.02	n= 33	n= 46	2.38*
	10.59 (2.61)	**10.61** (2.83)		**14.45** (2.81)	**12.95** (2.71)	
14.0-14.9	n= 50	n= 34	0.67	n= 32	n= 46	0.76
	11.49 (2.17)	**11.14** (2.57)		**14.29** (3.85)	**13.66** (3.24)	
15.0-15.9	n= 44	n= 27	2.08*	n= 48	n= 22	0.01
	12.79 (4.35)	**10.39** (3.15)		**15.21** (3.75)	**15.20** (3.55)	
16.0-16.9	n= 12	n= 48	0.81	n= 41	n= 14	0.39
	9.90 (2.23)	**10.53** (2.98)		**14.34** (3.12)	**13.99** (2.89)	
17.0-17.9	n= 03	n= 43	1.85	n= 29	n= 18	1.12
	8.40 (0.72)	**9.39** (2.18)		**14.25** (2.32)	**15.27** (3.41)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.49: Impact of physical activity on body mass index (kg/m^2) of adolescents of present study

Age groups	BMI (kg/m^2)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	8.30*	n= 16	n= 46	1.39
	15.52 (0.79)	**13.91** (0.51)		**14.25** (1.25)	**14.76** (1.25)	
11.0-11.9	n= 31	n= 32	6.98*	n= 22	n= 51	0.35
	16.24 (1.85)	**13.75** (0.72)		**14.92** (2.36)	**14.72** (2.27)	
12.0-12.9	n= 35	n= 30	4.96*	n= 21	n= 61	1.12
	17.02 (3.72)	**13.86** (0.59)		**15.91** (3.09)	**15.09** (2.13)	
13.0-13.9	n= 44	n= 33	8.57*	n= 33	n= 46	2.61*
	16.22 (1.69)	**13.80** (0.69)		**17.84** (2.33)	**16.55** (1.93)	
14.0-14.9	n= 50	n= 34	9.79*	n= 32	n= 46	0.43
	17.50 (2.01)	**14.47** (0.70)		**17.83** (2.83)	**17.58** (1.94)	
15.0-15.9	n= 44	n= 27	7.63*	n= 48	n= 22	0.19
	20.35 (4.20)	**15.31** (0.95)		**19.10** (3.15)	**18.96** (2.95)	
16.0-16.9	n= 12	n= 48	8.89*	n= 41	n= 14	0.14
	21.77 (1.44)	**17.62** (4.48)		**18.30** (2.35)	**18.20** (2.22)	
17.0-17.9	n= 03	n= 43	12.88*	n= 29	n= 18	0.00
	22.79 (0.47)	**18.05** (1.62)		**18.76** (1.96)	**18.77** (2.65)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.50: Impact of physical activity on conicity index of adolescents of present study

Age groups	CI					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	0.40	n= 16	n= 46	0.88
	1.18 (0.05)	**1.19** (0.05)		**1.22** (0.07)	**1.21** (0.08)	
11.0-11.9	n= 31	n= 32	1.78	n= 22	n= 51	0.02
	1.17 (0.08)	**1.20** (0.06)		**1.20** (0.12)	**1.20** (0.07)	
12.0-12.9	n= 35	n= 30	0.30	n= 21	n= 61	0.73
	1.18 (0.07)	**1.17** (0.05)		**1.16** (0.09)	**1.18** (0.09)	
13.0-13.9	n= 44	n= 33	1.66	n= 33	n= 46	0.26
	1.16 (0.07)	**1.19** (0.07)		**1.14** (0.07)	**1.15** (0.08)	
14.0-14.9	n= 50	n= 34	0.56	n= 32	n= 46	0.55
	1.17 (0.05)	**1.16** (0.07)		**1.13** (0.07)	**1.12** (0.05)	
15.0-15.9	n= 44	n= 27	2.43*	n= 48	n= 22	0.32
	1.17 (0.07)	**1.13** (0.06)		**1.12** (0.07)	**1.12** (0.07)	
16.0-16.9	n= 12	n= 48	0.73	n= 41	n= 14	0.62
	1.14 (0.04)	**1.15** (0.06)		**1.11** (0.08)	**1.10** (0.08)	
17.0-17.9	n= 03	n= 43	0.81	n= 29	n= 18	0.77
	1.08 (0.09)	**1.12** (0.06)		**1.12** (0.06)	**1.14** (0.09)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.51: Impact of physical activity on WHR of adolescents of present study

Age groups	WHR					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	0.06	n= 16	n= 46	0.72
	0.89 (0.03)	**0.89** (0.04)		**0.90** (0.05)	**0.89** (0.08)	
11.0-11.9	n= 31	n= 32	0.93	n= 22	n= 51	1.08
	0.88 (0.06)	**0.90** (0.07)		**0.88** (0.06)	**0.87** (0.05)	
12.0-12.9	n= 35	n= 30	1.24	n= 21	n= 61	0.31
	0.88 (0.05)	**0.87** (0.04)		**0.85** (0.05)	**0.84** (0.06)	
13.0-13.9	n= 44	n= 33	1.42	n= 33	n= 46	0.95
	0.87 (0.05)	**0.88** (0.05)		**0.81** (0.05)	**0.83** (0.05)	
14.0-14.9	n= 50	n= 34	0.02	n= 32	n= 46	0.00
	0.86 (0.04)	**0.86** (0.05)		**0.80** (0.05)	**0.80** (0.04)	
15.0-15.9	n= 44	n= 27	2.48*	n= 48	n= 22	0.81
	0.85 (0.05)	**0.82** (0.05)		**0.81** (0.07)	**0.80** (0.05)	
16.0-16.9	n= 12	n= 48	0.58	n= 41	n= 14	0.21
	0.83 (0.05)	**0.82** (0.04)		**0.80** (0.09)	**0.79** (0.04)	
17.0-17.9	n= 03	n= 43	0.26	n= 29	n= 18	0.49
	0.80 (0.09)	**0.81** (0.04)		**0.80** (0.05)	**0.81** (0.06)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.52: Impact of physical activity on WHTR of adolescents of present study

Age groups	WHTR					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21 **0.44** (0.02)	n= 35 **0.44** (0.03)	0.11	n= 16 **0.45** (0.03)	n= 46 **0.45** (0.03)	0.04
11.0-11.9	n= 31 **0.43** (0.04)	n= 32 **0.44** (0.04)	0.80	n= 22 **0.43** (0.04)	n= 51 **0.43** (0.04)	0.06
12.0-12.9	n= 35 **0.44** (0.06)	n= 30 **0.43** (0.03)	0.60	n= 21 **0.42** (0.04)	n= 61 **0.42** (0.04)	0.32
13.0-13.9	n= 44 **0.42** (0.03)	n= 33 **0.43** (0.03)	1.49	n= 33 **0.43** (0.05)	n= 46 **0.42** (0.02)	0.77
14.0-14.9	n= 50 **0.43** (0.03)	n= 34 **0.42** (0.04)	0.16	n= 32 **0.42** (0.05)	n= 46 **0.42** (0.03)	0.45
15.0-15.9	n= 44 **0.44** (0.07)	n= 27 **0.41** (0.04)	2.29*	n= 48 **0.43** (0.05)	n= 22 **0.43** (0.05)	0.11
16.0-16.9	n= 12 **0.41** (0.03)	n= 48 **0.42** (0.04)	0.61	n= 41 **0.42** (0.04)	n= 14 **0.41** (0.04)	0.62
17.0-17.9	n= 03 **0.41** (0.05)	n= 43 **0.41** (0.03)	0.08	n= 29 **0.43** (0.04)	n= 18 **0.43** (0.05)	0.14

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.53: Impact of physical activity on Subscapular- Triceps Ratio (STR) of adolescents of present study

Age groups	STR					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	0.52	n= 16	n= 46	1.58
	0.69 (0.14)	**0.67** (0.14)		**0.81** (0.16)	**0.73** (0.19)	
11.0-11.9	n= 31	n= 32	0.51	n= 22	n= 51	0.29
	0.75 (0.14)	**0.73** (0.20)		**0.83** (0.27)	**0.81** (0.32)	
12.0-12.9	n= 35	n= 30	0.81	n= 21	n= 61	0.29
	0.77 (0.21)	**0.73** (0.18)		**0.78** (0.15)	**0.79** (0.19)	
13.0-13.9	n= 44	n= 33	0.20	n= 33	n= 46	0.75
	0.72 (0.17)	**0.73** (0.21)		**0.93** (0.23)	**0.89** (0.25)	
14.0-14.9	n= 50	n= 34	0.31	n= 32	n= 46	0.31
	0.83 (0.23)	**0.84** (0.23)		**0.96** (0.19)	**0.94** (0.31)	
15.0-15.9	n= 44	n= 27	0.05	n= 48	n= 22	1.81
	1.13 (0.32)	**1.13** (0.25)		**1.13** (0.49)	**0.98** (0.18)	
16.0-16.9	n= 12	n= 48	1.75	n= 41	n= 14	2.22*
	1.37 (0.21)	**1.24** (0.27)		**0.99** (0.24)	**0.86** (0.16)	
17.0-17.9	n= 03	n= 43	1.12	n= 29	n= 18	1.67
	1.55 (0.26)	**1.38** (0.33)		**0.99** (0.24)	**1.25** (0.63)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.54: Impact of physical activity on Truncal - Extremity Fat Ratio (TEFR) of adolescents of present study

Age groups	TEFR					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21 **0.53** (0.08)	n= 35 **0.49** (0.09)	1.68	n= 16 **0.63** (0.15)	n= 46 **0.58** (0.09)	1.39
11.0-11.9	n= 31 **0.55** (0.10)	n= 32 **0.55** (0.12)	0.17	n= 22 **0.64** (0.13)	n= 51 **0.55** (0.12)	2.80*
12.0-12.9	n= 35 **0.57** (0.12)	n= 30 **0.53** (0.12)	1.18	n= 21 **0.61** (0.13)	n= 61 **0.58** (0.11)	1.02
13.0-13.9	n= 44 **0.53** (0.11)	n= 33 **0.54** (0.11)	0.54	n= 33 **0.69** (0.12)	n= 46 **0.66** (0.14)	0.88
14.0-14.9	n= 50 **0.59** (0.15)	n= 34 **0.60** (0.14)	0.36	n= 32 **0.72** (0.12)	n= 46 **0.72** (0.16)	0.08
15.0-15.9	n= 44 **0.73** (0.16)	n= 27 **0.75** (0.14)	0.55	n= 48 **0.76** (0.15)	n= 22 **0.74** (0.14)	0.46
16.0-16.9	n= 12 **0.86** (0.10)	n= 48 **0.79** (0.14)	1.12	n= 41 **0.75** (0.16)	n= 14 **0.68** (0.10)	1.80
17.0-17.9	n= 03 **0.86** (0.22)	n= 43 **0.86** (0.19)	0.02	n= 29 **0.71** (0.14)	n= 18 **0.80** (0.25)	1.43

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.55: Impact of physical activity on Centripetal Fat Ratio (CPFR) of adolescents of present study

Age groups	CPFR					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21 **40.43** (4.92)	n= 35 **39.69** (5.00)	0.54	n= 16 **44.34** (4.93)	n= 46 **41.61** (6.00)	1.80
11.0-11.9	n= 31 **42.52** (4.28)	n= 32 **41.50** (5.94)	0.79	n= 22 **44.39** (6.69)	n= 51 **43.40** (7.81)	0.55
12.0-12.9	n= 35 **42.59** (6.58)	n= 30 **41.55** (5.32)	0.70	n= 21 **43.32** (4.54)	n= 61 **43.43** (6.12)	0.09
13.0-13.9	n= 44 **41.44** (5.22)	n= 33 **41.50** (6.24)	0.05	n= 33 **47.56** (6.15)	n= 46 **46.38** (6.32)	0.83
14.0-14.9	n= 50 **44.43** (6.65)	n= 34 **44.98** (6.26)	0.38	n= 32 **48.50** (5.04)	n= 46 **47.32** (7.69)	0.82
15.0-15.9	n= 44 **52.02** (6.88)	n= 27 **52.44** (5.83)	0.28	n= 48 **51.43** (7.34)	n= 22 **49.13** (4.64)	1.59
16.0-16.9	n= 12 **57.45** (3.63)	n= 48 **54.69** (5.81)	2.06*	n= 41 **48.99** (5.76)	n= 14 **45.95** (4.28)	2.09*
17.0-17.9	n= 03 **60.56** (4.25)	n= 43 **57.15** (5.51)	1.31	n= 29 **49.00** (6.07)	n= 18 **53.12** (9.26)	1.68

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.56: Impact of physical activity on Sum of 5 Skinfolds (mm) of adolescents of present study

Age groups	S5S (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21 **32.11** (5.40)	n= 35 **35.63** (7.72)	2.01	n= 16 **42.04** (10.95)	n= 46 **44.56** (10.23)	0.80
11.0-11.9	n= 31 **40.09** (16.05)	n= 32 **38.98** (15.90)	0.28	n= 22 **48.54** (18.71)	n= 51 **45.91** (15.43)	0.58
12.0-12.9	n= 35 **41.62** (21.34)	n= 30 **42.00** (15.38)	0.10	n= 21 **50.44** (17.78)	n= 61 **46.47** (15.93)	0.91
13.0-13.9	n= 44 **39.61** (12.45)	n= 33 **39.36** (12.93)	0.09	n= 33 **62.87** (16.63)	n= 46 **55.09** (11.64)	2.31*
14.0-14.9	n= 50 **42.52** (11.88)	n= 34 **40.48** (13.05)	0.73	n= 32 **62.16** (18.28)	n= 46 **60.60** (14.70)	0.40
15.0-15.9	n= 44 **50.69** (23.15)	n= 27 **42.64** (16.24)	1.72	n= 48 **68.94** (19.95)	n= 22 **70.05** (19.25)	0.22
16.0-16.9	n= 12 **39.67** (10.43)	n= 48 **42.02** (14.61)	0.64	n= 41 **63.79** (14.80)	n= 14 **62.96** (18.07)	0.16
17.0-17.9	n= 03 **37.80** (8.39)	n= 43 **38.73** (7.88)	0.19	n= 29 **63.51** (13.74)	n= 18 **69.46** (15.44)	1.34

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.57: Impact of physical activity on Sum of Trunk Skinfolds (mm) of adolescents of present study

Age groups	STS (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	0.83	n= 16	n= 46	0.04
	11.10 (2.20)	**11.69** (3.10)		**16.33** (5.64)	**16.27** (4.51)	
11.0-11.9	n= 31	n= 32	0.11	n= 22	n= 51	1.23
	14.39 (7.35)	**14.17** (8.39)		**19.09** (8.89)	**16.43** (7.61)	
12.0-12.9	n= 35	n= 30	0.22	n= 21	n= 61	1.03
	15.35 (10.01)	**14.87** (7.69)		**19.44** (8.80)	**17.22** (7.62)	
13.0-13.9	n= 44	n= 33	0.13	n= 33	n= 46	2.20*
	13.67 (5.67)	**13.84** (6.10)		**25.93** (9.14)	**21.89** (6.23)	
14.0-14.9	n= 50	n= 34	0.36	n= 32	n= 46	0.57
	15.82 (6.27)	**15.29** (6.70)		**26.22** (8.96)	**25.13** (7.11)	
15.0-15.9	n= 44	n= 27	1.20	n= 48	n= 22	0.05
	21.39 (10.61)	**18.58** (8.86)		**30.03** (10.79)	**30.17** (10.12)	
16.0-16.9	n= 12	n= 48	0.07	n= 41	n= 14	0.67
	18.40 (6.23)	**18.55** (7.20)		**27.23** (7.65)	**25.54** (8.37)	
17.0-17.9	n= 03	n= 43	0.07	n= 29	n= 18	1.62
	17.60 (6.20)	**17.86** (4.70)		**26.40** (7.60)	**30.32** (8.34)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.58: Impact of physical activity on Sum of Extremity Skinfolds (mm) of adolescents of present study

Age groups	SES (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.48*	n= 16	n= 46	1.47
	21.01 (3.69)	**23.94** (5.15)		**25.72** (5.95)	**28.29** (6.26)	
11.0-11.9	n= 31	n= 32	0.42	n= 22	n= 51	0.02
	25.70 (9.02)	**24.81** (7.89)		**29.45** (10.24)	**29.48** (8.37)	
12.0-12.9	n= 35	n= 30	0.37	n= 21	n= 61	0.75
	26.27 (11.62)	**27.19** (8.23)		**31.00** (9.45)	**29.24** (8.80)	
13.0-13.9	n= 44	n= 33	0.25	n= 33	n= 46	2.24*
	25.94 (7.33)	**25.52** (7.47)		**36.94** (7.92)	**33.20** (6.42)	
14.0-14.9	n= 50	n= 34	1.00	n= 32	n= 46	0.22
	26.70 (6.59)	**25.18** (6.94)		**35.94** (9.87)	**35.47** (8.77)	
15.0-15.9	n= 44	n= 27	2.14*	n= 48	n= 22	0.39
	29.30 (12.95)	**24.07** (7.67)		**38.91** (9.99)	**39.88** (9.73)	
16.0-16.9	n= 12	n= 48	1.22	n= 41	n= 14	0.28
	21.27 (4.81)	**23.47** (7.95)		**36.56** (8.30)	**37.41** (10.33)	
17.0-17.9	n= 03	n= 43	0.43	n= 29	n= 18	0.74
	20.20 (2.50)	**20.88** (4.14)		**37.11** (7.13)	**39.13** (10.16)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.59: Impact of physical activity on Percent Body Fat (PBF %) of adolescents of present study

Age groups	PBF (%)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.58*	n= 16	n= 46	1.94
	13.11 (2.16)	**14.93** (3.12)		**15.46** (3.35)	**17.37** (3.52)	
11.0-11.9	n= 31	n= 32	0.32	n= 22	n= 51	0.52
	15.60 (4.69)	**15.25** (3.95)		**17.25** (5.69)	**17.95** (4.28)	
12.0-12.9	n= 35	n= 30	0.43	n= 21	n= 61	0.71
	15.76 (5.81)	**16.30** (4.33)		**18.63** (5.18)	**17.73** (4.66)	
13.0-13.9	n= 44	n= 33	0.13	n= 33	n= 46	2.09*
	15.78 (3.91)	**15.66** (4.10)		**21.62** (4.29)	**19.71** (3.56)	
14.0-14.9	n= 50	n= 34	0.79	n= 32	n= 46	0.25
	16.20 (3.37)	**15.57** (3.74)		**20.96** (5.16)	**21.25** (4.93)	
15.0-15.9	n= 44	n= 27	2.03*	n= 48	n= 22	0.80
	17.57 (6.66)	**14.94** (4.31)		**22.58** (5.35)	**23.66** (5.23)	
16.0-16.9	n= 12	n= 48	1.17	n= 41	n= 14	0.18
	13.34 (2.81)	**14.56** (4.55)		**21.78** (4.53)	**22.04** (4.93)	
17.0-17.9	n= 03	n= 43	1.42	n= 29	n= 18	0.45
	11.44 (1.81)	**13.02** (2.54)		**21.65** (3.87)	**22.32** (5.58)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.60: Impact of physical activity on Fat Mass (kg) of adolescents of present study

Age groups	FM (kg)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	3.01*	n= 16	n= 46	1.61
	2.97 (0.69)	**3.67** (1.04)		**3.67** (1.22)	**4.25** (1.33)	
11.0-11.9	n= 31	n= 32	0.24	n= 22	n= 51	0.11
	4.21 (2.09)	**4.10** (1.79)		**4.75** (2.56)	**4.82** (2.27)	
12.0-12.9	n= 35	n= 30	0.23	n= 21	n= 61	0.99
	5.08 (4.87)	**4.87** (2.25)		**6.28** (3.29)	**5.50** (2.53)	
13.0-13.9	n= 44	n= 33	0.35	n= 33	n= 46	3.13*
	4.51 (1.90)	**4.67** (2.09)		**8.87** (2.86)	**7.00** (2.24)	
14.0-14.9	n= 50	n= 34	0.75	n= 32	n= 46	0.16
	5.79 (2.28)	**5.44** (1.93)		**8.66** (3.69)	**8.54** (3.09)	
15.0-15.9	n= 44	n= 27	1.09	n= 48	n= 22	0.51
	8.46 (5.25)	**7.30** (3.67)		**10.05** (4.22)	**10.59** (4.00)	
16.0-16.9	n= 12	n= 48	1.41	n= 41	n= 14	0.23
	6.57 (1.67)	**7.54** (3.40)		**9.43** (3.11)	**9.70** (3.92)	
17.0-17.9	n= 03	n= 43	2.27	n= 29	n= 18	0.85
	5.50 (0.57)	**6.42** (1.56)		**9.31** (2.44)	**10.26** (4.30)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.61: Impact of physical activity on Fat Free Mass (kg) of adolescents of present study

Age groups	FFM (kg)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.55*	n= 16	n= 46	0.38
	19.53 (1.50)	**20.69** (1.86)		**19.65** (1.91)	**19.86** (1.90)	
11.0-11.9	n= 31	n= 32	0.67	n= 22	n= 51	0.86
	21.62 (2.78)	**22.07** (2.52)		**22.05** (3.38)	**21.32** (3.20)	
12.0-12.9	n= 35	n= 30	0.04	n= 21	n= 61	1.12
	23.97 (5.05)	**24.01** (3.76)		**25.81** (4.94)	**24.51** (3.49)	
13.0-13.9	n= 44	n= 33	1.03	n= 33	n= 46	3.43*
	23.34 (3.19)	**24.17** (3.75)		**31.21** (3.73)	**27.96** (4.68)	
14.0-14.9	n= 50	n= 34	0.07	n= 32	n= 46	0.46
	29.26 (6.95)	**29.35** (5.30)		**31.25** (4.26)	**30.83** (3.26)	
15.0-15.9	n= 44	n= 27	1.60	n= 48	n= 22	0.06
	37.06 (7.64)	**39.73** (6.29)		**33.07** (4.49)	**33.00** (4.25)	
16.0-16.9	n= 12	n= 48	0.22	n= 41	n= 14	0.02
	42.47 (4.71)	**42.81** (5.07)		**33.14** (3.25)	**33.16** (3.90)	
17.0-17.9	n= 03	n= 43	0.07	n= 29	n= 18	1.04
	42.83 (3.03)	**42.70** (4.84)		**33.17** (3.35)	**34.38** (4.16)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.62: Impact of physical activity on Fat Mass Index (kg/m^2) of adolescents of present study

Age groups	FMI (kg/m^2)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.26*	n= 16	n= 46	1.81
	1.90 (0.39)	**2.19** (0.59)		**2.23** (0.67)	**2.59** (0.72)	
11.0-11.9	n= 31	n= 32	0.27	n= 22	n= 51	0.25
	2.41 (1.07)	**2.34** (0.97)		**2.62** (1.32)	**2.71** (1.19)	
12.0-12.9	n= 35	n= 30	0.25	n= 21	n= 61	0.95
	2.68 (2.20)	**2.57** (1.04)		**3.09** (1.48)	**2.75** (1.14)	
13.0-13.9	n= 44	n= 33	0.13	n= 33	n= 46	2.55*
	2.42 (0.86)	**2.45** (0.92)		**3.94** (1.21)	**3.30** (0.89)	
14.0-14.9	n= 50	n= 34	0.55	n= 32	n= 46	0.16
	2.68 (0.85)	**2.57** (0.91)		**3.86** (1.57)	**3.80** (1.34)	
15.0-15.9	n= 44	n= 27	1.79	n= 48	n= 22	0.39
	3.51 (2.18)	**2.77** (1.29)		**4.44** (1.72)	**4.61** (1.70)	
16.0-16.9	n= 12	n= 48	1.22	n= 41	n= 14	0.07
	2.45 (0.63)	**2.76** (1.20)		**4.05** (1.35)	**4.08** (1.39)	
17.0-17.9	n= 03	n= 43	0.79	n= 29	n= 18	0.39
	2.19 (0.44)	**2.40** (0.61)		**4.11** (1.07)	**4.28** (1.65)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.63: Impact of physical activity on Fat Free Mass Index (kg/m^2) of adolescents of present study

Age groups	FFMI (kg/m^2)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	0.62	n= 16	n= 46	0.64
	12.51 (0.75)	**12.38** (0.73)		**12.02** (0.77)	**12.17** (0.76)	
11.0-11.9	n= 31	n= 32	0.17	n= 22	n= 51	0.70
	12.58 (0.10)	**12.63** (1.09)		**12.30** (1.73)	**12.01** (1.37)	
12.0-12.9	n= 35	n= 30	0.57	n= 21	n= 61	1.14
	13.03 (1.79)	**12.81** (1.26)		**12.82** (1.80)	**12.34** (1.26)	
13.0-13.9	n= 44	n= 33	0.70	n= 33	n= 46	2.26*
	12.67 (1.06)	**12.86** (1.28)		**13.91** (1.30)	**13.25** (1.26)	
14.0-14.9	n= 50	n= 34	0.38	n= 32	n= 46	0.65
	13.59 (1.73)	**13.71** (1.38)		**13.97** (1.46)	**13.77** (1.01)	
15.0-15.9	n= 44	n= 27	0.15	n= 48	n= 22	0.78
	15.24 (2.96)	**15.15** (1.89)		**14.66** (1.71)	**14.35** (1.50)	
16.0-16.9	n= 12	n= 48	0.17	n= 41	n= 14	0.30
	15.81 (1.39)	**15.73** (1.58)		**14.24** (1.40)	**14.12** (1.29)	
17.0-17.9	n= 03	n= 43	2.23	n= 29	n= 18	0.41
	16.84 (0.57)	**15.91** (1.66)		**14.65** (1.17)	**14.48** (1.51)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.64: Impact of physical activity on Arm Muscle Circumference (mm) of adolescents of present study

Age groups	AMC (mm)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	0.61	n= 16	n= 46	0.46
	142.05 (5.59)	**143.39** (10.73)		**139.74** (7.79)	**140.88** (10.38)	
11.0-11.9	n= 31	n= 32	0.34	n= 22	n= 51	2.56*
	145.56 (11.06)	**146.59** (12.81)		**151.39** (15.16)	**141.85** (13.20)	
12.0-12.9	n= 35	n= 30	0.28	n= 21	n= 61	1.21
	154.11 (21.95)	**152.80** (15.71)		**156.24** (18.74)	**150.93** (12.64)	
13.0-13.9	n= 44	n= 33	1.41	n= 33	n= 46	1.56
	148.71 (12.17)	**153.76** (17.62)		**168.36** (12.80)	**162.43** (20.90)	
14.0-14.9	n= 50	n= 34	0.26	n= 32	n= 46	0.79
	166.19 (21.48)	**167.31** (17.51)		**174.73** (24.10)	**171.00** (14.19)	
15.0-15.9	n= 44	n= 27	0.56	n= 48	n= 22	0.22
	189.16 (24.55)	**192.07** (19.03)		**176.17** (23.08)	**175.04** (17.99)	
16.0-16.9	n= 12	n= 48	0.51	n= 41	n= 14	0.17
	202.07 (11.57)	**204.18** (17.46)		**170.95** (17.89)	**170.12** (15.47)	
17.0-17.9	n= 03	n= 43	1.10	n= 29	n= 18	0.81
	212.44 (7.24)	**207.06** (16.88)		**176.30** (11.37)	**180.14** (18.06)	

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.65: Impact of physical activity on Arm Muscle Area (mm^2) of adolescents of present study

Age groups	AMA (mm^2)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21 **1607.60** (128.75)	n= 35 **1644.50** (250.56)	0.73	n= 16 **1557.80** (176.53)	n= 46 **1587.20** (239.21)	0.52
11.0-11.9	n= 31 **1694.80** (268.77)	n= 32 **1721.90** (304.10)	0.38	n= 22 **1840.50** (386.14)	n= 51 **1614.20** (303.24)	2.44*
12.0-12.9	n= 35 **1926.40** (644.32)	n= 30 **1876.20** (403.76)	0.38	n= 21 **1968.30** (486.89)	n= 61 **1824.60** (301.40)	1.27
13.0-13.9	n= 44 **1770.70** (298.37)	n= 33 **1904.5** (490.10)	1.39	n= 33 **2267.30** (350.47)	n= 46 **2132.60** (621.49)	1.22
14.0-14.9	n= 50 **2233.00** (596.84)	n= 34 **2250.40** (485.76)	0.15	n= 32 **2473.40** (758.57)	n= 46 **2341.70** (390.85)	0.90
15.0-15.9	n= 44 **2893.00** (738.77)	n= 27 **2962.40** (595.24)	0.43	n= 48 **2510.10** (763.53)	n= 22 **2461.70** (519.58)	0.31
16.0-16.9	n= 12 **3257.60** (367.00)	n= 48 **3340.10** (578.79)	0.61	n= 41 **2349.40** (520.91)	n= 14 **2319.90** (437.17)	0.21
17.0-17.9	n= 03 **3592.70** (244.23)	n= 43 **3432.70** (561.32)	0.97	n= 29 **2482.50** (325.07)	n= 18 **2605.70** (525.98)	0.89

Standard deviations are presented in parentheses
*Significant at level 0.05

Table 9.66: Impact of physical activity on Arm Fat Area (mm^2) of adolescents of present study

Age groups	AFA (mm^2)					
	Boys			Girls		
	NPE	PE	t- value	NPE	PE	t- value
10.0-10.9	n= 21	n= 35	2.03*	n= 16	n= 46	2.10*
	709.64 (165.14)	**824.51** (257.94)		**859.98** (295.45)	**1046.60** (334.44)	
11.0-11.9	n= 31	n= 32	0.73	n= 22	n= 51	0.14
	826.61 (376.53)	**897.26** (394.43)		**1076.50** (580.24)	**1056.70** (441.70)	
12.0-12.9	n= 35	n= 30	0.22	n= 21	n= 61	0.62
	962.49 (754.34)	**929.65** (416.79)		**1212.40** (602.92)	**1121.20** (529.89)	
13.0-13.9	n= 44	n= 33	0.06	n= 33	n= 46	1.87
	893.93 (372.00)	**898.87** (387.34)		**1513.90** (535.11)	**1313.10** (362.33)	
14.0-14.9	n= 50	n= 34	0.78	n= 32	n= 46	0.78
	936.80 (376.84)	**874.14** (352.87)		**1462.00** (594.85)	**1571.00** (617.95)	
15.0-15.9	n= 44	n= 27	1.63	n= 48	n= 22	1.12
	1152.50 (735.58)	**918.44** (472.92)		**1649.30** (668.60)	**1851.40** (715.82)	
16.0-16.9	n= 12	n= 48	1.47	n= 41	n= 14	0.55
	792.27 (265.63)	**955.05** (553.51)		**1570.40** (543.92)	**1691.10** (759.60)	
17.0-17.9	n= 03	n= 43	0.89	n= 29	n= 18	0.18
	683.38 (252.96)	**816.93** (236.77)		**1592.70** (464.32)	**1628.7** (750.02)	

Standard deviations are presented in parentheses
*Significant at level 0.05