



## **A COMPARATIVE STUDY ON CIRCUMFERENCE OF SELECTED BODY PARTS OF 13 YEARS OLD BOYS OF FOUR DIFFERENT ALTITUDES OF DARJEELING DISTRICT**

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### **ABSTRACT**

*The purpose of the study was to find out the difference in circumference of different Body parts of 13 years old boys of Darjeeling. The samples are school students. Researcher had taken 100 male students each from Sukhia Pokhari Higher Secondary School (Alt.-7200 ft.), Trunbull higher Secondary school (Alt.-6700 ft.), Jnanpith High school (Alt.-3000 ft.) and Kadamtala High School(Alt.-430 ft.). Researcher had measured height and weight as personal data measured circumference of head, neck, arm relax, flex arm, waist, gluteal, calf and ankle. It has been observed that there were significant differences in neck, wrist and calf circumference.*

**Keywords:** Body composition, Motor performance, Male students.

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### **Contribution/ Originality**

This research paper will contribute in the few existing literature of anthropometry especially conducted in the hilly area of Darjeeling. This study uses new estimation methodology and tried to provide the unbiased and exact findings. It is a thrust area of research as there are differences in circumference of different body parts due to altitude variation. The paper's primary contribution is finding that how difference in circumference of selected body parts occurs with increases or decreases in altitude and to set the physical education programme according to the health status of the child.

### **1. INTRODUCTION**

The body fat percentage is a measure of fitness level, since it is the only body measurement which directly calculates a person's relative body composition without regard to height or weight. The widely used body mass index (BMI) provides a measure that allows the comparison of the adiposity of individuals of different heights and weights. While BMI largely increases as adiposity increases, due to differences in body composition, it is not an accurate indicator of body fat; for

example, individuals with greater muscle mass will have higher BMIs. The thresholds between "normal" and "overweight" and between "overweight" and "obese" are sometimes disputed for this reason. Body compositions including circumference of different parts are the determinant factor for physical performance especially in the activities where the total body has to be moved. In addition substantial amount of evidence are available to notify that length, breadth and girth of the body bone has an immense impact on physical performance and similarly high percentage of body fat not only serves as dead weight but it also reveals that the relative ability to supply oxygen to the working muscles thus cutting down on cardio-vascular endurance. [Cureton \*et al.\* \(1975\)](#) concluded that body density, body potassium and skinfold thickness predicted performances equally well when age, height weight were held constant. It was concluded that not only variation in body size but also variation in body composition should be considered when interpreting results of A.H.P.E.R test for individual children and comparison of group of children who differ in body composition.

Here as narrated in the title 'altitude' means height. As we go up the hills we have to accompanied with various changes such as decrease in total barometric pressure, decrease in partial pressure in oxygen, decrease in density of air, cooler and dryer air, climatic change like low temperature, nature of daily activity, haemoglobin quantity etc. From various studies it has become clear that altitude has a great effect on physical as well as anthropometric status of the population.

As the body parts circumference is discussed above now let us understand why we can expect the variation in above mention factors in different altitude. Firstly in this paper, body composition means circumference of a body parts. Generally it is known that with increase in altitude temperatures decreases and in this study there are four different altitudes i.e, 430 ft., 3000 ft., 6700 ft. and 7200 ft. so as we know that fat is used as insulator by human body we can aspect the thicker layer of fat with increase in altitude. Apart from this, genetic factor may also play a vital role in greater circumference in higher altitude. It will be very interesting if we get clues regarding anthropometric variation including pattern of growth, fat deposition etc. in respect of altitude from the study.

## **2. METHODS**

### **2.1. Purpose of the Study**

The purpose of the study was to find out the difference in circumference of head, neck, arm relax, flex arm, waist, gluteal, calf and ankle of 13 years old school going male adolescents.

### **2.2. The Subjects**

One hundred school going male students from four different altitudes were selected randomly as the subject of study. The altitudes were 430 feet, 3000 feet, 6700 feet and 7200 feet respectively. The age of the subjects was 13 years.

### 2.3. Criterion Measures

Researcher had measured age, height and weight as personal data and measured the following parameters;

Table-1. Criterion measures

Personal Data	Circumference
1. Age 2. Height 3. weight	1. Head, 2. Neck, 3. arm relax, 4. flex arm, 5. waist, 6. gluteal, 7. calf and 8. Ankle.

### 3. RESULT AND DISCUSSION

Table-2. Mean and S.D of height and weight of four different altitudes

Altitude	N	Height				Weight			
		Mean	SD	SEm (±)	CD (P=0.05)	Mean	SD	SEm (±)	CD (P=0.05)
Age 13									
Sukhiapokhori HS School	37	1.48	0.084	0.012	NS	37.30	5.211	0.937	NS
Trunbull HS School	25	1.47	0.069	0.015	NS	35.96	5.712	1.140	NS
Jnanpith High School	25	1.45	0.076	0.015	NS	35.40	4.752	1.140	NS
Kadamtala High School	25	1.47	0.074	0.015	NS	39.04	7.086	1.140	NS

From the above table it was found that the mean height of Group-I (7200 ft.), Group-II (6700 ft.), Group-III (3000 ft.) and Group-IV (430 ft.) were 1.48 mt., 1.47 mt, 1.45 mt. and 1.47 mt. Similarly the mean weights were 37.30 kg., 35.96 kg., 35.40 kg. and 39.04 kg.

Table-3. Mean, S.D., SEm and critical difference of circumference of adolescence of four different altitudes

Altitude	N	Head				Neck			
		Mean	SD	SEm (±)	CD (P=0.05)	Mean	SD	SEm (±)	CD (P=0.05)
Age 13									
Sukhiapokhori HS School	37	51.88	1.440	0.234	NS	29.24	1.900	0.289	0.810
Trunbull HS School	25	51.79	1.443	0.285	NS	28.37	1.486	0.351	0.984
Jnanpith High School	25	52.02	1.179	0.285	NS	28.79	1.449	0.351	0.984
Kadamtala High School	25	51.72	1.602	0.285	NS	27.90	2.040	0.351	0.984
		Arm relax				Flex arm			
Age 13									
Sukhiapokhori HS School	37	19.77	1.744	0.300	NS	21.39	2.076	0.336	NS
Trunbull HS School	25	19.96	1.647	0.364	NS	21.86	2.124	0.409	NS
Jnanpith High School	25	19.70	1.188	0.364	NS	21.84	1.389	0.409	NS
Kadamtala High School	25	19.06	2.501	0.364	NS	21.00	2.427	0.409	NS
		Forearm				Wrist			
Age 13									
Sukhiapokhori HS School	37	20.13	1.921	0.280	NS	15.33	2.669	0.284	0.796
Trunbull HS School	25	20.81	1.826	0.341	NS	15.39	1.164	0.345	0.967
Jnanpith High School	25	20.38	1.000	0.341	NS	14.73	0.614	0.345	0.967

Kadamtala High School	25	19.96	1.787	0.341	NS	14.11	1.005	0.345	0.967
		Waist				Gluteal			
Age 13									
Sukhiapokhori HS School	37	60.13	6.016	1.047	NS	71.97	5.317	0.893	NS
Trunbull HS School	25	58.12	6.755	1.274	NS	73.48	4.949	1.087	NS
Jnanpith High School	25	59.63	3.655	1.274	NS	71.59	4.661	1.087	NS
Kadamtala High School	25	61.14	8.318	1.274	NS	71.65	6.649	1.087	NS
		Calf				Ankle			
Age 13									
Sukhiapokhori HS School	37	27.65	2.923	0.428	1.200	19.29	1.116	0.299	NS
Trunbull HS School	25	28.86	1.824	0.521	1.460	19.96	1.523	0.363	NS
Jnanpith High School	25	27.87	1.518	0.521	1.460	18.88	1.125	0.363	NS
Kadamtala High School	25	26.75	3.475	0.521	1.460	18.73	3.065	0.363	NS

Table-4. Analysis of variance of skinfold measurements

Source	Head					Neck				
	Sum Squares	of df	Mean Square	F	Sig.	Sum Squares	of df	Mean Square	F	Sig.
Altitude	1.325	3	.442	.217	.884	29.725	3	9.908	3.211	.026
Error	219.614	108	2.033			333.253	108	3.086		
Total	301365.74	112				92272.180	112			
	Arm relax					Flex arm				
Source	Sum Squares	of df	Mean Square	F	Sig.	Sum Squares	of df	Mean Square	F	Sig.
Altitude	11.779	3	3.926	1.183	.320	12.707	3	4.236	1.014	.390
Error	358.486	108	3.319			451.212	108	4.178		
Total	43564.91	112				52283.23	112			
	Forearm					Wrist				
Source	Sum Squares	of df	Mean Square	F	Sig.	Sum Squares	of df	Mean Square	F	Sig.
Altitude	10.676	3	3.559	1.226	.304	28.948	3	9.649	3.234	.025
Error	313.533	108	2.903			322.236	108	2.984		
Total	46466.11	112				25344.610	112			
	Waist					Gluteal				
Source	Sum Squares	of df	Mean Square	F	Sig.	Sum Squares	of df	Mean Square	F	Sig.
Altitude	120.044	3	40.015	.987	.402	59.136	3	19.712	.668	.574
Error	4379.175	108	40.548			3188.224	108	29.521		
Total	404967.86	112				586291.51	112			
	Calf					Ankle				
Source	Sum Squares	of df	Mean Square	F	Sig.	Sum Squares	of df	Mean Square	F	Sig.
Altitude	56.575	3	18.858	2.780	.045	22.877	3	7.626	2.311	.080
Error	732.729	108	6.785			356.372	108	3.300		
Total	87147.34	112				41759.140	112			

Table-5. Least Significant Difference and Multiple Comparisons for skinfold measurement

(I) Altitude	(J) Altitude	Head		Neck	
		Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.
Sukhiapokhori HS School	Trunbull HS School	0.088	0.813	0.875	0.057
	Jnanpith High School	-0.148	0.689	0.451	0.323
	Kadamtala High School	0.160	0.666	1.347*	0.004
Trunbull HS School	Jnanpith High School	-0.236	0.560	-0.424	0.395
	Kadamtala High School	0.072	0.859	0.472	0.344
Jnanpith High School	Kadamtala High School	0.308	0.447	0.896	0.074
		Arm relax		Flex arm	
Sukhiapokhori HS School	Trunbull HS School	-0.180	0.699	-0.472	0.374
	Jnanpith High School	0.070	0.884	-0.444	0.403
	Kadamtala High School	0.720	0.131	0.388	0.465
Trunbull HS School	Jnanpith High School	0.250	0.626	0.028	0.961
	Kadamtala High School	0.900	0.084	0.860	0.140
Jnanpith High School	Kadamtala High School	0.650	0.211	0.832	0.153
		Forearm		Wrist	
Sukhiapokhori HS School	Trunbull HS School	-0.681	0.126	-0.062	0.890
	Jnanpith High School	-0.253	0.568	0.598	0.184
	Kadamtala High School	0.171	0.699	1.218*	0.008
Trunbull HS School	Jnanpith High School	0.428	0.376	0.660	0.180
	Kadamtala High School	0.852	0.080	1.280*	0.010
Jnanpith High School	Kadamtala High School	0.424	0.381	0.620	0.207
		Waist		Gluteal	
Sukhiapokhori HS School	Trunbull HS School	2.00	0.227	-1.506	0.287
	Jnanpith High School	0.50	0.765	0.378	0.789
	Kadamtala High School	-1.02	0.539	0.318	0.821
Trunbull HS School	Jnanpith High School	-1.51	0.404	1.884	0.223
	Kadamtala High School	-3.02	0.096	1.824	0.238
Jnanpith High School	Kadamtala High School	-1.51	0.403	-0.060	0.969
		Calf		Ankle	
Sukhiapokhori HS School	Trunbull HS School	-1.209	0.076	-0.671	0.157
	Jnanpith High School	-0.217	0.749	0.413	0.382
	Kadamtala High School	0.903	0.183	0.561	0.235
Trunbull HS School	Jnanpith High School	0.992	0.181	1.084*	0.037
	Kadamtala High School	2.112*	0.005	1.232*	0.018
Jnanpith High School	Kadamtala High School	1.120	0.131	0.148	0.774

From table, it was found that in the age group of 13, the mean circumference of head of Group-A (7200 ft.) was 51.88 cm. which was second among the groups with standard deviation of 1.440; in the same manner the mean head circumference of Group-B (6700 ft.) was 51.79cm. which was third in the groups with variation of 1.443, the mean value of Group-C (3000 ft.) was highest among the group and the mean value was 52.02cm. with variation of 1.179 and the Group-D (430 ft.) was the lowest in group having mean head circumference of 51.72cm. with standard deviation of 1.602. As there was slight difference in head circumference among the 13 years boys of four

different altitudes, analysis of variance was conducted in table-11B where “F” value found shows no significant difference. Further L.S.D was conducted in table-11C to know whether the difference may occur in between the groups, which show no significant difference. For head circumference of age group 13, groups may be arranged in descending order as Group-C>Group-A>Group-B>Group-D.

It was found from the study of [Zaki et al. \(2008\)](#), the average head circumference of 13 year old Egyptian adolescents was 53.46 cm. with S.D of 1.53.

Similarly from above table, in the age group of 13 years, the mean value of neck circumference of Group-A was 29.24cm. which was first among the group with standard deviation of 1.900; in the same manner the mean value of neck circumference of Group-B was 28.37cm. which ranks third in the group with variation of 1.486, the mean value of Group-C was second highest among the group and the mean value was 28.79 cm. with variation of 1.449 and the Group-D was the lowest ranking group having mean value of neck circumference of 27.90cm. with standard deviation of 2.040. As Critical difference was significant in neck circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-11B where “F” value (3.211) shows significant difference. So further L.S.D was conducted in table-11C and it was found that there was significant difference between Group-A and Group-D.

From above table, it was found that in the age group of 13, the mean circumference of arm of Group-A (7200 ft.) was 19.77 cm. which was second among the groups with standard deviation of 1.744; in the same manner the mean arm circumference of Group-B (6700 ft.) was 19.96cm. which was highest in the groups with variation of 1.647, the mean value of Group-C (3000 ft.) was third among the group and the mean value was 19.70cm. with variation of 1.188 and the Group-D (430 ft.) was the lowest in group having mean arm circumference of 19.06 cm. with standard deviation of 2.501. Though there was no significant critical difference in arm circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-12B where “F” value (1.183) found shows no significant difference. Further L.S.D was conducted in table-12C to know whether the difference may occur in between the groups, which show no significant difference. For Arm circumference of age group 13, groups may be arranged in descending order as Group-B>Group-A>Group-C>Group-D.

It was found from the study of [Fryar et al. \(2012\)](#), the average arm circumference of 13 year old adolescents of United States was 27 cm. with SEM of 0.42, for Chhattisgarh Jawahar Navodaya Vidyalaya adolescents it was 20.96cm. with S.D of 1.91 and for Chhattisgarh Kendriya Vidyalaya students it was 22.06cm.with S.D of 2.81 ([Shukla et al., 2008](#)), for Shabar Tribal Adolescents of Orissa it was 18.2 cm. with S.D of 1.8 ([Chakrabarty and Bharati, 2008](#)) and for Bengali Boys of Nimta, North 24 Parganas, West Bengal it was 19.4 cm. with S.D of 2.5 ([Mukhopadhyay et al., 2005](#)) and for male students of 24 Pgs (N), West Bengal, it was 22.42cm. with S.D of 3.11([Paul, 2013](#)). Analysing the result of arm circumference it may be concluded that the present study has close proximity to [Mukhopadhyay et al. \(2005\)](#).

Similarly it was found from the above table that in the age group of 13 years, the mean value of flex arm circumference of Group-A was 21.39 cm. which was third among the group with standard deviation of 2.076; in the same manner the mean value of flex arm circumference of Group-B was 21.86 cm. which ranks first in the group with variation of 2.124, the mean value of Group-C was second highest among the group and the mean value was 21.84 cm. with variation of 1.389 and the Group-D was the lowest ranking group having mean value of flex arm circumference of 21.00cm. with standard deviation of 2.427. Though there was no significant critical difference in flex arm circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-12B where “F” value (1.014) found shows no significant difference. Further L.S.D was conducted in table-12C to know whether the difference may occur in between the groups, which also shows no significant difference. For Flex arm circumference of age group 13, groups may be arranged in descending order as Group-B>Group-C>Group-A>Group-D.

From above table, it was found that in the age group of 13, the mean circumference of forearm of Group-A (7200 ft.) was 20.13 cm. which was third among the groups with standard deviation of 1.921; in the same manner the mean forearm circumference of Group-B (6700 ft.) was 20.81cm. which was first in the groups with variation of 1.826, the mean value of Group-C (3000 ft.) was second highest among the group and the mean value was 20.38cm. with variation of 1.000 and the Group-D (430 ft.) was the lowest in group having mean forearm circumference of 19.96cm. with standard deviation of 1.787. As there was slight difference in head circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-13B where “F” value (1.226) found shows no significant difference. Further L.S.D was conducted in table-13C to know whether the difference may occur in between the groups, which show no significant difference. For Forearm circumference of age group 13, groups may be arranged in descending order as Group-B>Group-C>Group-A>Group-D.

Similarly it was found from above table that in the age group of 13 years, the mean value of wrist circumference of Group-A was 15.33cm. which was second among the group with standard deviation of 2.669; in the same manner the mean value of wrist circumference of Group-B was 15.39cm. which ranks first in the group with variation of 1.164, the mean value of Group-C was third among the group and the mean value was 14.73 cm. with variation of .614 and the Group-D was the lowest ranking group having mean value of wrist circumference of 14.11cm. with standard deviation of 1.005. As Critical difference was significant in wrist circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-13B where “F” value (3.234) shows significant difference. So further L.S.D was conducted in table-13C to know where the difference lies and it was found that there was significant difference between Group-A and Group-D and between Group-B and Group-D. For Wrist circumference of age group 13, groups may be arranged in descending order as Group-B>Group-A>Group-C>Group-D.

It was found from the study of Ramezankhani *et al.* (2011) that the average wrist circumference of 13 years old Iranian adolescents was 16.15 cm. with S.D of 1.19.

From above table, in the age group of 13, the mean circumference of waist of Group-A (7200 ft.) was 60.13 cm. which was second among the groups with standard deviation of 6.016; in the same manner the mean waist circumference of Group-B (6700 ft.) was 58.12cm. which was lowest in the groups with variation of 6.755, the mean value of Group-C (3000 ft.) was third among the group and the mean value was 59.63cm. with variation of 3.655 and the Group-D (430 ft.) was the highest in group having mean waist circumference of 61.14 cm. with standard deviation of 8.318. Though there was no significant critical difference in waist circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-14B where “F” value (.987) found shows no significant difference. Further L.S.D was conducted in table-14C which shows no any significant difference. For Waist circumference of age group 13, groups may be arranged in descending order as Group-D>Group-A>Group-C>Group-B.

It was found from the study of Fryar *et al.* (2012), the average waist circumference of 13 year old adolescents of united states was 76.8 cm. with SEM of 1.34, for Shabar Tribal Adolescents of Orissa it was 56.7 cm. with S.D of 5.3 (Chakrabarty and Bharati, 2008) and for Bengali Boys of Nimta, North 24 Parganas, West Bengal it was 58.9 cm. with S.D of 5.6 (Mukhopadhyay *et al.*, 2005).

Similarly from above table, in the age group of 13 years, the mean value of gluteal circumference of Group-A was 71.97 cm. which was second among the group with standard deviation of 5.317; in the same manner the mean value of gluteal circumference of Group-B was 73.48 cm. which ranks first in the group with variation of 4.949, the mean value of Group-C was lowest among the group and the mean value was 71.59 cm. with variation of 4.661 and the Group-D was the third ranking group having mean value of gluteal circumference of 71.65cm. with standard deviation of 6.649. Though there was no significant critical difference in gluteal circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-14B where “F” value (.668) found shows no significant difference. Further L.S.D was conducted in table-14C which also does not show any significant difference. For Gluteal circumference of age group 13, groups may be arranged in descending order as Group-B>Group-A>Group-C>Group-D.

It was found from the study of Chakrabarty and Bharati (2008) that the average gluteal (hip) circumference of 13 year old Shabar Tribal Adolescents of Orissa was 66.2 cm. with S.D of 5.8and for Bengali Boys of Nimta, North 24 Parganas, West Bengal it was 70.9 cm. with S.D of 6.2 (Mukhopadhyay *et al.*, 2005).

From above table, in the age group of 13, the mean circumference of calf of Group-A (7200 ft.) was 27.65 cm. which was third among the groups with standard deviation of 2.923; in the same manner the mean calf circumference of Group-B (6700 ft.) was 28.86cm. which was highest in the groups with variation of 1.824, the mean value of Group-C (3000 ft.) was second among the group and the mean value was 27.87cm. with variation of 1.518 and the Group-D (430 ft.) was the



lowest in group having mean calf circumference of 26.75 cm. with standard deviation of 3.475. As there was critical difference in calf circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-15B where “F” value (2.780) found shows significant difference. So further L.S.D was conducted in table-15C and it was found that there was significant difference between Group-B and Group-D. For Calf circumference of age group 13, groups may be arranged in descending order as Group-B>Group-C>Group-A>Group-D.

It was found from the study of Margaret McDowell *et al.* (2008), the average calf circumference of 13 year old adolescents of united states was 34.9 cm. with SEM of 0.36, for Chhattisgarh J. N. Vidyalaya adolescents it was 29.5 cm. with S.D of 2.37 and for Chhattisgarh K. V. students it was 29.93 cm. with S.D of 2.85 (Shukla *et al.*, 2008), for Shabar Tribal Adolescents of Orissa it was 27.9cm. with S.D of 1.1 (Chakrabarty and Bharati, 2008) and for Bengali Boys of Nimta, North 24 Parganas, West Bengal it was 27.1 cm. with S.D of 2.9 (Mukhopadhyay *et al.*, 2005). Analysing the result of calf circumference it may be concluded that the present study has close proximity to Chakrabarty and Bharati (2008) and Mukhopadhyay *et al.* (2005).

Similarly from above table, in the age group of 13 years, the mean value of ankle circumference of Group-A was 19.29 cm. which was second among the group with standard deviation of 1.116; in the same manner the mean value of ankle circumference of Group-B was 19.96 cm. which ranks first in the group with variation of 1.523, the mean value of Group-C was third highest among the group and the mean value was 18.88 cm. with variation of 1.125 and the Group-D was the lowest ranking group having mean value of ankle circumference of 18.73 cm. with standard deviation of 3.065. Though there was no significant critical difference in ankle circumference among the 13 years boys of four different altitudes, analysis of variance was conducted in table-15B where “F” value (2.311) found shows no significant difference. Further L.S.D was conducted in table-15C which shows significant difference between Group-B and Group-C and between Group-B and Group-D. For Ankle circumference of age group 13, groups may be arranged in descending order as Group-B>Group-A>Group-C>Group-D.

#### 4. CONCLUSION

From above findings following conclusions can be drawn;

- Group-A (Altitude-7200 ft.) male students had greater neck circumference among four different altitudes.
- Group-B (Altitude-6700 ft.) male students had greater relax arm, flexed arm, forearm, wrist, gluteal, calf and ankle circumference among four different altitudes.
- Group-C (Altitude-3000 ft.) male student had greater head circumference.
- Group-D (Altitude-430 ft.) male students had greater waist and calf circumference among four different altitudes.

#### 5. RECOMMENDATION

- Similar type of study can be done for different age groups.

- Similar type of study can be done on other anthropometric measurements.
- Similar type of study can be done on different altitude.

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