

The Effect of Altitude on Growth of Anthropometric and Motor Performance of 14 Year Old Adolescence

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Citation: Gurung JC. The Effect of Altitude on Growth of Anthropometric and Motor Performance of 14 Year Old Adolescence. *Electronic J Biol*, 13:4

Received: July 04, 2017; **Accepted:** December 15, 2017; **Published:** December 22, 2017

Research Article

Abstract

The intention of the study was to find out the difference in some anthropometric measurements including bone length, skinfolds and motor performance of 14 years old boys of Darjeeling. The samples are school students. Researcher had taken 112 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 and measured length of Sitting Height, Foot Length, Acromiale-Radiale, Radiale-Styilion Radiale, Midstyilion-Dactyilion, Trochanterion-Tibiale Laterale, Tibiale Mediale-Sphyrion Tibiale, Tibiale Laterale Height, skinfold measurements of Triceps Skinfold Thickness, Biceps Skinfold Thickness, Subscapular Skinfold Thickness, Iliac creast Skinfold Thickness, Supra spinale Skinfold Thickness, Abdominal Skinfold Thickness and Medial calf Skinfold Thickness and similarly the motor performance including 50 m dash, Standing broad jump, Sit ups and Shuttle run.

It has been observed that there were significant differences in growth of foot length, acromiale radiale, radiale-styilion radiale, midstyilion-dactyilion, trochanterion-tibiale laterale and tiabile med-sphyrion tibiale. There is significant fat accumulation of fat on medial calf region due to altitude difference. Researcher also got significant difference in performance of shuttle run and sit ups performance due to variation in altitude.

Keywords: Bone length; Skinfold thickness; Motor performance; Male students.

1. Introduction

Various researches regarding altitude and its effect on human body have been done and researches reveal that there is an effect of altitude on human body. These research will help to prepare diet chart for school students and take preventive measure as what body type they have and susceptible to which disease according to their body type [1-3].

Variation in anthropometric and motor performance

due to altitude is a huge concern of research. The performance of athletes in Mexico Olympic has force researchers to think about effect of altitude on human body [4]. With increase in altitude physiological changes like increase in haemoglobin, lung's alveoli, etc., due to low air pressure has encourage coaches and trainers to train their athletes in high altitudes. Researcher wants to find out how altitude effects on growth of our bones, fat accumulation as well as motor performance of an individuals. Even physical appearance of the individuals residing at different altitudes seems different. So altitude has always been a mystery to the researcher. People residing at high altitude will have more blood compare to individual residing at low altitude so athletes and coaches prefer high altitude training than blood dopping to enhance their performance in their respective sports [5,6].

2. Methods

2.1 Purpose of the study

The purpose of the study was to find out the effects of living altitudes on bone growth, skinfold thickness and motor performance of 14 years old school going male adolescents of four different altitudes of Darjeeling district. 100 students were taken for the research.

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 ft, 3000 ft, 6700 ft and 7200 ft, respectively. The age of the subjects was 14 years taken from school records.

2.3 Criterion measures

Researcher had measured age, height and weight as personal data and measured the following parameters (Table 1).

From Table 2 it was found that the mean height of Group-A (7200 ft), Group-B (6700 ft), Group-C (3000 ft) and Group-D (430 ft) were 1.52 m, 1.56 m, 1.57 m and 1.58 m Similarly the mean weights were 41.12 kg, 43.04 kg, 42.88 kg and 44.20 kg.

Table 1. Criterion measures.

Personal Data (Age, Height, Weight)	Circumference: Sitting Height, Foot Length, Acromiale-Radiale, Radiale-Stylian Radiale, Midstylian-Dactylian, Trochanterion-Tibiale Laterale, Tibiale Mediale-Sphyrion Tibiale, Tibiale Laterale Height
Motor Performance (50 m dash, Standing broad jump, Sit ups and Shuttle run)	Skinfold Thickness: Triceps Skinfold Thickness, Biceps Skinfold Thickness, Subscapular Skinfold Thickness, Iliac creast Skinfold Thickness, Supra spinale Skinfold Thickness, Abdominal Skinfold Thickness and Medial calf Skinfold Thickness

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

Altitude	N	Height				Weight			
		Mean (meter)	SD	SEM (±)	CD (P=0.05)	Mean (Kg)	SD	SEM (±)	CD (P=0.05)
Age 14									
Group-A (7200 ft)	25	1.52	0.077	0.014	0.039	41.12	6.790	1.337	NS
Group-B (6700 ft)	25	1.56	0.074	0.014	0.039	43.04	7.684	1.337	NS
Group-C (3000 ft)	25	1.57	0.054	0.014	0.039	42.88	4.790	1.337	NS
Group-D (430 ft)	25	1.58	0.065	0.014	0.039	44.20	7.118	1.337	NS

Table 3A. Mean and S.D of linear measurements of four different altitudes.

Altitude	N	Sitting Height				Foot length			
		Mean (cm.)	SD	SEm (±)	CD (P=0.05)	Mean (cm.)	SD	SEm (±)	CD (P=0.05)
Age 14									
Group-A (7200 ft)	25	78.76	3.597	0.805	NS	23.11	1.713	0.252	0.706
Group-B (6700 ft)	25	80.36	4.760	0.805	NS	22.34	1.416	0.252	0.706
Group-C (3000 ft)	25	81.72	3.857	0.805	NS	22.77	0.495	0.252	0.706
Group-D (430 ft)	25	80.56	3.787	0.805	NS	23.69	1.079	0.252	0.706
Age 14									
		Acromiale radiale				Radiale-Stylian Radiale			
Group-A (7200 ft)	25	25.03	2.326	0.408	1.144	21.70	1.320	0.299	0.838
Group-B (6700 ft)	25	25.72	2.766	0.408	1.144	22.71	2.192	0.299	0.838
Group-C (3000 ft)	25	25.98	1.453	0.408	1.144	22.10	0.904	0.299	0.838
Group-D (430 ft)	25	27.95	1.215	0.408	1.144	22.91	1.254	0.299	0.838
Age 14									
		Midstylian-dactylian				Trochanterion-Tibiale Laterale			
Group-A (7200 ft)	25	15.19	0.909	0.164	0.460	35.21	2.818	0.591	1.657
Group-B (6700 ft)	25	17.37	0.869	0.164	0.460	33.26	3.417	0.591	1.657
Group-C (3000 ft)	25	15.74	0.421	0.164	0.460	36.50	3.000	0.591	1.657
Group-D (430 ft)	25	16.34	0.958	0.164	0.460	36.20	2.508	0.591	1.657
Age 14									
		Tibiale med-sphyrion tibiale				Tibiale laterale height			
Group-A (7200 ft)	25	33.64	3.414	0.503	1.410	39.54	3.615	0.577	NS
Group-B (6700 ft)	25	35.62	2.670	0.503	1.410	40.62	3.375	0.577	NS
Group-C (3000 ft)	25	34.72	1.869	0.503	1.410	40.78	1.972	0.577	NS
Group-D (430 ft)	25	36.64	1.738	0.503	1.410	40.92	2.226	0.577	NS

3. Results and Discussion

3.1 Overall results and discussion on sitting height and foot length

From Tables 3A-3C, it was found that the higher growth in sitting height occurs at an altitude of 3000 ft (Group-C) followed by Group-D (430 ft), Group-B (6700 ft) and Group-A (7200 ft).

It was found from the study of some researchers that the average sitting height was found. For 14 year old under privileged North West Indian adolescents it was 78.01 cm with S.D of 5.77 and for Chhattisgarh Jawahar Navodaya Vidyalaya adolescents it was

78.11 cm with S.D of 4.71 and for Chhattisgarh Kendriya Vidyalaya students it was 81.41 cm with S.D of 4.47 [7] and for Shabar Tribal Adolescents of Orissa it was 72.7 cm with S.D of 3.6 and for male students of 24 Pgs (N), West Bengal, it was 73.20 cm with S.D of 4.02. Analysing the result of sitting it may be concluded that the present study has close proximity to Shukla et al. [7].

Similarly the higher growth in foot length was found at an altitude of 430 ft. For Foot length growth, groups may be arranged in descending order as Group-D>Group-A>Group-C>Group-B. Results from the present study show that with decrease in altitude foot length increases.

Table 3B. Analysis of linear measurements of four different altitudes.

Source	Sitting Height					Foot length				
	Sum of Squares	df	Mean Square	F	Sig.	Sum of Squares	df	Mean Square	F	Sig.
Age 14										
Altitude	111.23	3	37.077	2.288	0.083	24.262	3	8.087	5.093	0.003
Error	1555.52	96	16.203			152.435	96	1.588		
Total	647279	100				52970.95	100			
Age 14										
Acromiale radiale					Radiale-Styilion Radiale					
Altitude	117.601	3	39.2	9.418	0	23.172	3	7.724	3.457	0.019
Error	399.576	96	4.162			214.494	96	2.234		
Total	69019.77	100				50216.74	100			
Age 14										
Midstylium-dactylium					Trochanterion-Tibiale Laterale					
Altitude	65.012	3	21.671	32.382	0	160.495	3	53.498	6.13	0.001
Error	64.245	96	0.669			837.763	96	8.727		
Total	26244.14	100				125579	100			
Age 14										
Tibiale med-sphyriion tibiale					Tibiale laterale height					
Altitude	122.229	3	40.743	6.443	0.001	29.341	3	9.78	1.175	0.324
Error	607.098	96	6.324			799.286	96	8.326		
Total	124316.7	100				164570.3	100			

Table 3C. Least significant difference and multiple comparisons for linear measurements.

(I) Altitude	(J) Altitude	Sitting Height		Foot length	
		Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.
Age 14					
Group-A	Group-B	-1.6	0.163	0.7680*	0.034
	Group-C	-2.96*	0.011	0.336	0.348
	Group-D	-1.8	0.117	-0.58	0.107
Group-B	Group-C	-1.36	0.235	-0.432	0.228
	Group-D	-0.2	0.861	-1.3480*	0
Group-C	Group-D	1.16	0.311	-0.9160*	0.012
Age 14					
		Acromiale radiale		Radiale-Styilion Radiale	
Group-A	Group-B	-0.692	0.233	-1.008*	0.019
	Group-C	-0.952	0.102	-0.404	0.342
	Group-D	-2.920*	0	-1.212*	0.005
Group-B	Group-C	-0.26	0.653	0.604	0.156
	Group-D	-2.228*	0	-0.204	0.631
Group-C	Group-D	-1.968*	0.001	-0.808	0.059
Age 14					
		Midstylium-dactylium		Trochanterion-Tibiale Laterale	
Group-A	Group-B	-2.176*	0	1.948*	0.022
	Group-C	-0.552*	0.019	-1.292	0.125
	Group-D	-1.144*	0	-0.992	0.238
Group-B	Group-C	1.624*	0	-3.240*	0
	Group-D	1.032*	0	-2.940*	0.001
Jnanpith High School	Group-D	-0.592*	0.012	0.3	0.72
Age 14					
		Tibiale mediale-sphyriion tibiale		Tibiale laterale height	
Group-A	Group-B	-1.9800*	0.006	-1.08	0.189
	Group-C	-1.072	0.135	-1.232	0.134
	Group-D	-2.9920*	0	-1.372	0.096
Group-B	Group-C	0.908	0.205	-0.152	0.853
	Group-D	-1.012	0.158	-0.292	0.721
Group-C	Group-D	-1.9200*	0.008	-0.14	0.864

3.2 Overall results and discussion on acromiale radiale and radiale-styilion radiale

From the study it was found that the growth rate of

acromiale radiale was higher at an altitude of 430 ft (Group-D). Growth of acromiale radiale may be arranged in descending order as Group-D>Group-C>Group-B>Group-A [8,9].

It was found from the study of Fryar et al. [4] that the average length of acromiale radiale of 14 year old adolescents of United States was 36.3 cm. with SEM of 0.25.

The growth of radiale-styilion radiale was higher at an altitude of 430 ft (Group-D). For Radiale-styilion radiale growth, groups may be arranged in descending order as Group-D>Group-B>Group-C>Group-A.

It was found that students residing at lowest altitude have longer acromiale radiale and genetic factors may be behind this reality. Apart from genetic factors these male students belong to urban areas and being from lower middle class family they had to travel hanging inside the bus with their hands everyday may lead to longer acromiale radiale.

3.3 Overall results and discussion on midstylium-dactylium and trochanterion-tibiale laterale length

From the study it was found that the growth rate of Midstylium-dactylium was higher at an altitude of 6700 feet (Group-B). For Midstylium-dactylium growth, groups may be arranged in descending order as Group-B>Group-D>Group-C>Group-A.

The growth of Trochanterion-tibiale laterale length was higher at an altitude of 3000 ft (Group-C). For Trochanterion-tibiale laterale growth, groups may be arranged in descending order as Group-C>Group-D>Group-A>Group-B.

It was found from the study of Fryar et al. [4] that the average length of Trochanterion-Tibiale Laterale

(upper leg length) of 14 year old adolescents of United States was 40.5 cm with SEM of 0.28.

3.4 Overall results and discussion on tibiale laterale height and tibiale mediale-sphyrion tibiale length

From the study it was found that the growth rate of Tibiale mediale-sphyrion tibiale was higher at an altitude of 6700 ft (Group-B). For Tibiale mediale-sphyrion tibiale growth, groups may be arranged in descending order as Group-D>Group-B>Group-C>Group-A.

The growth of Tibiale laterale height was higher at an altitude of 430 ft (Group-D). For Tibiale laterale height growth pattern, groups may be arranged in descending order as Group-D>Group-C>Group-B>Group-A. During 13 years, tibiale laterale height was longer in lowest altitude but with increase in age growth rate of highest altitude becomes more.

3.5 Overall results and discussion on triceps skinfold thickness

From the Tables 4A-4C, it was found that fat accumulation in triceps region was found more at an altitude of 6700 ft (Group-B). For triceps growth, 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. [4], the average triceps skinfold thickness of 14 year old adolescents of United States was 12.9 mm with SEM of 0.83; for Shabar Tribal Adolescents of Orissa, it was 5.6 mm with S.D of 1.8 [10] and for Bengali Boys

Table 4A. Mean and S.D of skinfold thickness of four different altitudes.

Altitude	N	Triceps				Mean (mm.)	SD	SEM (±)	CD (P=0.05)
		Mean (mm)	SD	SEM (±)	CD (P=0.05)				
Age 14									
Group-A (7200 ft)	25	4.27	1.422	0.247	NS	-	-	-	-
Group-B (6700 ft)	25	4.46	1.466	0.247	NS	-	-	-	-
Group-C (3000 ft)	25	3.92	0.686	0.247	NS	-	-	-	-
Group-D (430 ft)	25	3.57	1.203	0.247	NS	-	-	-	-
Age 14									
		Biceps				Sub Scapular			
Group-A (7200 ft)	25	2.04	0.476	0.110	NS	3.67	1.121	0.181	NS
Group-B (6700 ft)	25	2.24	0.688	0.110	NS	3.78	1.014	0.181	NS
Group-C (3000 ft)	25	2.03	0.346	0.110	NS	3.59	0.737	0.181	NS
Group-D (430 ft)	25	2.03	0.619	0.110	NS	3.76	0.681	0.181	NS
Age 14									
		Iliac Crest				Supra Spinale			
Group-A (7200 ft)	25	3.99	1.722	0.327	NS	3.16	1.277	0.266	NS
Group-B (6700 ft)	25	4.64	2.341	0.327	NS	3.51	1.512	0.266	NS
Group-C (3000 ft)	25	4.12	0.850	0.327	NS	3.44	0.844	0.266	NS
Group-D (430 ft)	25	4.39	1.229	0.327	NS	3.49	1.557	0.266	NS
Age 14									
		Abdominal				Medial Calf			
Group-A (7200 ft)	25	4.19	1.706	0.321	NS	3.48	0.905	0.214	0.600
Group-B (6700 ft)	25	4.53	2.116	0.321	NS	4.61	1.699	0.214	0.600
Group-C (3000 ft)	25	4.32	0.894	0.321	NS	3.26	0.584	0.214	0.600
Group-D (430 ft)	25	4.48	1.460	0.321	NS	3.50	0.735	0.214	0.600

of Nimta, North 24 Parganas, West Bengal it was 7.3 mm with S.D of 2.4 [1].

3.6 Overall results and discussion on biceps and sub scapular skinfold thickness

From the study it was found that fat accumulation in biceps region was found more at an altitude of 6700 ft (Group-B). For biceps growth, 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 [10] that the average biceps skinfold thickness of 14 year old Shabar Tribal Adolescents of Orissa was 3.2 mm with S.D of 0.6 and for Bengali Boys of Nimta, West Bengal it was 4.6 mm with S.D of 1.7 [1].

From the study it was found that fat accumulation in sub scapular region was found more at an altitude of 6700 ft (Group-B). For sub scapular growth, groups may be arranged in descending order as Group-B>Group-D>Group-A>Group-C.

It was found from the study of Fryar et al. [4], the average sub scapular skinfold thickness of 14 year

old adolescents of united states was 11 mm with SEM of 0.68, for Shabar Tribal Adolescents of Orissa it was 7 with S.D of 1.6 [10] and for Bengali Boys of Nimta, North 24 Parganas, West Bengal it was 9.3 mm with S.D of 3.7 [1].

3.7 Overall results and discussion on iliac crest and supra spinale skinfold thickness

From the study it was found that fat accumulation in biceps region was found more at an altitude of 6700 ft (Group-B). For iliac crest growth, groups may be arranged in descending order as Group-B>Group-D>Group-C>Group-A.

It was found from the study of Chakrabarty and Bharati [10] that the average Iliac crest skinfold thickness of 14 year old Shabar Tribal Adolescents of Orissa was 5.7 mm with S.D of 1.5 and for Bengali Boys of Nimta, North 24 Parganas, West Bengal it was 9.5 mm with S.D of 4.3 [1].

It was found that fat accumulation in supra spinale region was found more at an altitude of 6700 ft (Group-B). For supra spinale growth, it may be arranged in descending order as Group-B>Group-D>Group-C>Group-A.

Table 4B. Analysis of skinfold thickness of four different altitudes.

(I) Altitude	(J) Altitude	Triceps			
		Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.
Age 14					
Group-A	Group-B	-0.192	0.584	-	-
	Group-C	0.348	0.321	-	-
	Group-D	0.700*	0.048	-	-
Group-B	Group-C	0.540	0.125	-	-
	Group-D	0.892*	0.012	-	-
Group-C	Group-D	0.352	0.316	-	-
Age 14		Biceps		Sub Scapular	
Group-A	Group-B	-0.200	0.200	-0.112	0.663
	Group-C	0.008	0.959	0.076	0.768
	Group-D	0.004	0.979	-0.088	0.732
Group-B	Group-C	0.208	0.183	0.188	0.466
	Group-D	0.204	0.191	0.024	0.926
Group-C	Group-D	-0.004	0.979	-0.164	0.524
Age 14		Iliac Crest		Supra Spinale	
Group-A	Group-B	-0.656	0.159	-0.356	0.346
	Group-C	-0.128	0.782	-0.280	0.458
	Group-D	-0.404	0.384	-0.336	0.373
Group-B	Group-C	0.528	0.256	0.076	0.840
	Group-D	0.252	0.587	0.020	0.958
Group-C	Group-D	-0.276	0.552	-0.056	0.882
Age 14		Abdominal		Medial Calf	
Group-A	Group-B	-0.344	0.451	-1.136*	0.000
	Group-C	-0.132	0.772	0.212	0.486
	Group-D	-0.296	0.516	-0.020	0.947
Group-B	Group-C	0.212	0.642	1.348*	0.000
	Group-D	0.048	0.916	1.116*	0.000
Group-C	Group-D	-0.164	0.719	-0.232	0.446

Table 4C. Least significant difference and multiple comparisons for skinfold thickness.

Source	Triceps									
	Sum of Squares	df	Mean Square	F	Sig.	Sum of Squares	df	Mean Square	F	Sig.
Age 14										
Altitude	11.62	3	3.873	2.544	0.061	-	-	-	-	-
Error	146.169	96	1.523	-	-	-	-	-	-	-
Total	1801.28	100	-	-	-	-	-	-	-	-
Age 14	Biceps					Sub Scapular				
Altitude	0.781	3	0.26	0.866	0.462	0.556	3	0.185	0.225	0.879
Error	28.86	96	0.301	-	-	79.014	96	0.823	-	-
Total	463.53	100	-	-	-	1447.83	100	-	-	-
Age 14	Iliac Crest					Supra Spinale				
Altitude	6.428	3	2.143	0.803	0.495	2.046	3	0.682	0.387	0.763
Error	256.22	96	2.669	-	-	169.284	96	1.763	-	-
Total	2098.77	100	-	-	-	1326.65	100	-	-	-
Age 14	Abdominal					Medial Calf				
Altitude	1.86	3	0.62	0.24	0.868	27.826	3	9.275	8.089	0
Error	247.634	96	2.58	-	-	110.079	96	1.147	-	-
Total	2168.81	100	-	-	-	1515.8	100	-	-	-

It was found from the study that the average supra spinale skinfold thickness of 13-15 years old adolescents of Zaria, Nigeria was 0.48 cm with S.D of 0.15.

3.8 Overall results and discussion on abdominal and medial calf skinfold thickness

From the study it was found that fat accumulation in abdominal region was found more at an altitude of 6700 ft (Group-B). For abdominal skinfold thickness growth, groups may be arranged in descending order as Group-B>Group-D>Group-C>Group-A.

It was found from the study of Chakrabarty and Bharati [10] that the average abdominal skinfold thickness of 14 year old Shabar Tribal Adolescents of

Orissa was 7.1 mm with S.D of 2.4.

It was found that fat accumulation in medial calf region was found more at an altitude of 6700 ft (Group-B). For medial calf skin fold thickness growth, groups may be arranged in descending order as Group-B>Group-D>Group-A>Group-C.

It was found from the study of Mukhopadhyay et al. [1] that the average medial calf skinfold thickness of 14 year old Bengali Boys of North 24 Parganas, W. Bengal was 8.4 mm. with S.D of 2.2 (Tables 5A-5C).

3.9 Overall results and discussion on shuttle run and 50 m dash

From the study it was found that performance

Table 5A. Mean and S.D of motor performance of four different altitudes.

Altitude	N	Shuttle Run				50 mt.dash			
		Mean (seconds, s)	SD	SEm (±)	CD (P=0.05)	Mean (seconds, s)	SD	SEm (±)	CD (P=0.05)
Age 14									
Group-A (7200 ft)	25	11.93	0.817	0.118	0.331	8.60	0.466	0.088	NS
Group-B (6700 ft)	25	11.18	0.470	0.118	0.331	8.66	0.402	0.088	NS
Group-C (3000 ft)	25	10.62	0.474	0.118	0.331	8.45	0.333	0.088	NS
Group-D (430 ft)	25	11.67	0.521	0.118	0.331	8.77	0.529	0.088	NS
Age 14		Standing Broad Jump				Sit Ups			
Group-A (7200 ft)	25	1.70	0.179	0.032	NS	15.00	3.617	0.581	1.629
Group-B (6700 ft)	25	1.76	0.187	0.032	NS	17.48	2.330	0.581	1.629
Group-C (3000 ft)	25	1.72	0.128	0.032	NS	15.48	2.163	0.581	1.629
Group-D (430 ft)	25	1.72	0.129	0.032	NS	20.76	3.257	0.581	1.629

Table 5B. Analysis of motor performance of four different altitudes.

Source	Shuttle Run					50 mt. dash				
	Sum of Squares	df	Mean Square	F	Sig.	Sum of Squares	df	Mean Square	F	Sig.
Age 14										
Altitude	25.085	3	8.362	24.169	0.000	1.403	3	0.468	2.431	0.070
Error	33.214	96	0.346	-	-	18.464	96	.192	-	-
Total	12936.46	100	-	-	-	7448.583	100	-	-	-
Age 14										
	Standing Broad Jump					Sit Ups				
Altitude	0.049	3	0.016	0.647	0.587	513.720	3	171.24	20.269	0.000
Error	2.401	96	0.025	-	-	811.040	96	8.448	-	-
Total	300.289	100	-	-	-	30840.000	100	-	-	-

Table 5C. Least significant difference and multiple comparisons for motor performance.

(I) Altitude	(J) Altitude	Shuttle Run		50 m dash	
		Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.
Age 14					
Group-A	Group-B	0.7492*	0.000	-0.0584	0.639
	Group-C	1.3100*	0.000	0.1540	0.217
	Group-D	0.2552	0.128	-0.1748	0.162
Group-B	Group-C	0.5608*	0.001	0.2124	0.090
	Group-D	-0.4940*	0.004	-0.1164	0.350
Group-C	Group-D	-1.0548*	0.000	-0.3288*	0.009
Age 14		Standing Broad Jump		Sit Ups	
Group-A	Group-B	-0.0588	0.192	-2.4800*	0.003
	Group-C	-0.0168	0.708	-0.4800	0.561
	Group-D	-0.0132	0.769	-5.7600*	0.000
Group-B	Group-C	0.0420	0.350	2.0000*	0.017
	Group-D	0.0456	0.311	-3.2800*	0.000
Group-C	Group-D	0.0036	0.936	-5.2800*	0.000

in shuttle run was more at an altitude of 3000 ft (Group-C). For Shuttle run performance, groups may be arranged according to superiority in descending order as Group-C>Group-B>Group-D>Group-A.

It was found from the study of Paul [9], the average shuttle run speed (m/s) of 14 year old male students of 24 Pgs (N), West Bengal was 11.20 s with S.D of 0.46 and worldwide average shuttle run speed was 11.517 with S.D of 1.323. Analysing the result of shuttle run it may be concluded that the present study has close proximity to Paul [9].

It was found that performance in 50 m Dash was more at an altitude of 3000 ft (Group-C). For 50 m Dash performance, groups may be arranged according to superiority in descending order as Group-C>Group-A>Group-B>Group-D.

It was found from the study of Paul [9], the average 50 m run speed (m/s) of 14 year old male students of 24 Pgs (N), West Bengal was 8.36 s with S.D of 0.72.

3.10 Overall results and discussion on S.B.J and sit ups

From the study it was found that performance in standing broad jump was more at an altitude of 6700 ft (Group-B). For standing broad jump of age group

14, groups may be arranged in descending order as Group-B>Group-C=Group-D>Group-A.

It was found from the study of Paul [9], the average standing broad jump of 14 year old male students of 24 Pgs (N), West Bengal was 171.37 cm with S.D of 15.92 and for Macedonian school children it was 180.5 cm with S.D of 28.07. Analysing the result of standing broad jump it may be concluded that the present study has close proximity to Paul [9].

It was found that performance in sit ups was more at an altitude of 430 feet (Group-D). For sit ups, i.e., abdominal strength performance, groups may be arranged in descending order as Group-D>Group-B>Group-C>Group-A.

4. Conclusion

From above findings following conclusions can be drawn:

- Group-B (Altitude-6700 ft) male students had greater Midsthylium-dactylion, growth and greater Triceps, Biceps, Sub Scapular, IliacCreast, Supra Spinale, Abdominal and Medial Calf skinfold thickness and can perform better in Standing Broad Jump among four different altitudes.

- Group-C (Altitude-3000 ft) male student had greater Sitting Height, Trochanterion-Tibiale Laterale length and perform better in Shuttle Run and 50 m dash.
- Group-D (Altitude-430 ft) male student had greater Foot length, Acromiale radiale, Radiale-Stylion Radiale, Tibiale med-sphyrion tibiale, Tibiale laterale height and perform better in Sit Ups 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.
- Study regarding the causes behind such variation in growth can be done.

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